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THE MOUNTAINS OF NORTHERN SIKKIM AND GARHWAL.*

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Along the northern border of India stretches the most stupendous mountain barrier in the world. The main axis of the series of parallel ranges and mountain masses known collectively as the Himalaya extends for about 1500 miles from east to west, and only comparatively small sections have so far been explored. The present communication deals chiefly with the northern portion of Sikkim, and is essentially a continuation of the exploration carried out by Mr. Freshfield, and reported to this Society. The mountains of Garhwal were also visited.

I have made three journeys to Sikkim in the years 1907, 1909, and 1911. In 1907 Swiss guides were taken, but they proved unsatisfactory, and in 1909 and 1911 only natives were employed. These natives were either Nepalese, Lepchas, or Bhutias. The Sherpas, who come from Eastern Nepal, were found to be the best, and they can be safely recommended to travellers.

My main object was to explore the glaciers of Kangchenjunga, and to ascend any mountains of the region which might prove accessible. Scientific work in connection with variations in the composition of the atmosphere at high altitudes, and alterations in the relative numbers of the red and white corpuscles in blood was attempted. It was intended also to make observations with regard to the so-called mountain sickness.

About the middle of April of last year (1911) I left Darjeeling with forty-four coolies, and in eight days reached the village of Lachen, situated at an elevation of 10,000 feet, in the upper Tista valley, about 110 miles north of Darjeeling by road. The scenery of the foothills passed through on the way has been so thoroughly and interestingly described by the late

* Royal Geographical Society, April 1, 1912. Map, p. 352.

Sir Joseph Hooker and Mr. Freshfield that we may start our journey at Lachen.

Having sent on a considerable quantity of stores to Thango, about 12 miles to the north on the Tibetan road, we left Lachen on April 24 with thirty-one coolies, eight of whom were Sherpa Nepalese, who were to remain with us permanently, the remaining twenty-three being Lachen men, who were to return after four days' march to the north west.

At Zemu Samdong (Zemu Bridge), about 2 miles north of Lachen, one leaves the pony track leading to Thango and Tibet, and proceeds through forest along the side of the Zemu river, which is followed to its source about 15 miles off in the glacier of the same name. This glacier drains the east face of Kangchenjunga. Between Lachen and the end of the Zemu glacier is generally considered a three days' march on the upward journey, as the route is very rough.

Many different types of animals are met with in these upper valleys. A few miles beyond Zemu Samdong the Lachen men lassoed a mountain fox. They wished to sell me the animal, declaring that its skin would fetch a considerable sum in Calcutta, but released it on my refusal. I was glad that they did not kill the creature for its long fur, which was a beautiful brown and black. It would be better if only dangerous predaceous creatures like bears and wolves, or game which is plentiful like hares, were killed in these upper valleys for some time. The Government is fortunately restricting the number of each of the different species of animals which may be shot on one gun licence.

On the fifth day from Lachen we reached the Green lake, situated at 15,300 feet, about 12 miles up the Zemu glacier. Here we found most of the ground deep in snow, and the Green lake itself only half its summer size, the eastern portion being a muddy flat. In summer the length is about a quarter of a mile.

From this point of view the tremendous mass of Kangchenjunga, which forms a most imposing series of precipitous ridges, effectually blocks the Zemu on the west. The chief peak (28,150 feet) is 8 miles south-west of the Green lake. The Himalaya here consists of three parallel chains running east and west, cut at right angles by the main Kangchenjunga ridge, which runs north and south. The Zemu glacier lies between the southern and central ranges.

Before exploring the glaciers on the flanks of Kangchenjunga, our intention was to force a pass suitable for laden coolies across the central range to Lhonak, the name given to the district between the central and northern ranges. The central range rises to a little over 20,000 feet near the Green lake. We made five attempts, but only managed to force two passes, one of which was suitable for coolies. We began with two frontal attacks. The first attempt was made on a ridge leading up to a small snow-peak north-east of the camp, but after ascending to 18,000 feet, we found it to be unsuitable for coolies, but practicable for a roped party.

We next tried further to the west, close to Green Lake mountain, but a heavily crevassed glacier was met with, only passable with difficulty by laden coolies. Here I was partially incapacitated for some days through slipping on glazed rocks. The accident was due to an experiment with boots two sizes too large with two pairs of socks, admirable for wading in deep snow in the early morning, but quite unsuitable for rocks.

The camp was then moved round to a small plain adjacent to the Tent Peak glacier, the main northern affluent of the Zemu glacier (marked as Green Lake glacier on Prof. Garwood's map). On the following day the main icefall of this glacier was climbed. This icefall looks much more formidable than it really is, but at the same time requires care. One found the coolies inclined to sit and smoke the inevitable cigarettes right under most dangerous seracs from which tons of ice might have fallen at any moment. After pointing out the dangers a few times they became quite cautious. Two coolies named Sona and Tuny were found to be good at ice-work, especially the latter, who is by far the best all-round coolie that I have ever met with. His ice-steps were admirable. At the top of the icefall, which is about 1000 feet high, we found that although the east Tent Peak glacier was a maze of crevasses, it would be possible to advance up its true left to the top of a pass just under a buttress of the Tent peak. Prof. Garwood's map here requires correction. It shows the east Tent Peak glacier as stretching up to the Pyramid, 3 miles further to the north-west, but this ground drains to Lhonak.

An easier route than that up the Tent Peak glacier seemed to lead north-eastwards up a tributary glacier, coming down from a plateau which obviously connected with Lhonak. The Nepal gap to the west seemed so easy that we could hardly credit that there must be a rise of 5000 feet from our camp to its summit.

Perhaps a few words might be said here with regard to the nomenclature employed in this paper. The system of naming the mountains is the same as that followed by Mr. Freshfield in his book 'Round Kangchenjunga,' namely, to give them descriptive designations, either from their form or position. Glaciers are named either from the chief peak feeding them, from the pass at their head, the place at which they debouch, or from the river flowing from them. In a case where several glaciers flow from one mountain, they are named after the peak with a prefix indicating direction of flow, unless a good special name is possible.

On the following morning at 6 a.m. we started for the Nepal gap instead of attempting the pass, because I was still a semi-invalid from the accident of three days before, and had on the previous day required considerable help from the rope in ascending the icefall. The Nepal gap (21,000 feet) is the first pass in the great ridge running northwards from the highest summit of Kangchenjunga. We had to cross the main Tent Peak glacier, and proceed up its western branch, which might be distinguished as the Nepal gap glacier. In about a couple of miles we came

to an awkward icefall, which took us nearly two hours to negotiate. It was far more difficult than when visited on two previous occasions (1907 and 1909), the arrangement of the seracs having entirely altered. We went right up through the centre of it, some gymnastics being required. Deep troughs containing ice-covered lakelets constituted one of the main difficulties. Above the icefall I had expected that we would proceed rapidly, but the crevasses were far more numerous than we expected, and up to 2 p.m. the glare of the sun was very trying, the heat being terrific, until quite suddenly, on reaching about 20,000 feet, we passed into an icy-cold wind, which was pouring through the gap from the west. The sun became obscured, mists swept up rapidly, and the coolies wished to turn back. As we had been as far in 1909, I had to refuse. Progress after that was slow. The wind coming through the gap became a gale, and was piercingly cold. The snow was frozen on the surface, but soft beneath, and we sank nearly to the knees. The coolies complained of incipient frost-bite, and we had to stop until they had rubbed their feet, and put dried grass, of which they carried a small supply, into their boots. About 3.15 we reached the base of the small rock wall at an elevation of 20,850 feet, which formed the summit of the pass (21,000 feet). This ridge was not difficult on the right, and although we were all extraordinarily tired (probably because we had done too much in the preceding week), I was strongly averse to turning back without climbing it, but Sona showed me that some of his toes looked white and numb, and to climb the wall might have taken at least half an hour in our exhausted condition. We therefore retreated as rapidly as possible, but, owing to our meeting with a second set of seracs below the icefall, we were delayed nearly three-quarters of an hour, and did not reach our camp until 6.30 p.m. I would strongly recommend any one attempting to cross the Nepal gap—and probably the other side, though steep, is not impossible—to camp above the main icefall of the Nepal gap glacier, so as to leave plenty of time for the upper portion. The map was found to be inaccurate with regard to the connection between the Sugarloaf and Twins groups. These are separate, and connected by a low, narrow col. It is also incorrect with regard to the mountain group to the west of the Nepal gap, which has no direct connection with the Twins group.

On the second day after attacking the Nepal gap, having moved the camp up about 500 feet, we proceeded to attempt the pass into Lhonak. The great icefall having been surmounted, we turned up the centre of the glacier on the east. After encountering very considerable difficulty with crevasses, we gained the dividing ridge. The view from the summit was interesting. Due north was the Chorten Nima La, practically free from snow on its south side. To the west lay the Langpo and Pyramid peaks. The pass has been named Lhonak La, and its elevation is about 19,500 feet. As it was only one o'clock, I wished to descend to Lhonak, and force our way back over the gap which lay at the head of the Tent Peak

glacier, it being at least 500 feet lower than our pass. The coolies, however, were strongly against the idea, and I thought it well to give in. Sona, who, as I learned by experience, was rather a pessimist, declared that the other side of Tent Peak pass was a sheer precipice, and that we would be benighted without food or shelter.

On investigation next day it was found that Tent Peak pass was an easy snow slope on the north side, and exclamations of "Achchha" (good) were heard in the camp throughout the evening. The coolies were delighted, because if we could not have managed the Tent Peak pass, they might have had to carry the baggage over the Tang-chung and Thé passes about 12 miles to the east. There are here two ridges between the Zemu glen and Lhonak, the central range forking a few miles east of the Green lake. As it would have taken between two and three weeks by that route, since there were more than three loads to each coolie, the saving of time and trouble was considerable. Four coolies were told off to move the baggage under Tandook's direction over Tent Peak pass, while the other three, including Sona and Tuny, came with me to attempt the Zemu gap and Simvu saddle.

These are two possible passes over the southern range already mentioned. The Zemu gap, the more westerly of the two, lies between Kangchenjunga and Simvu (22,360 feet), and the Simvu saddle between the latter mountain and Siniolchum (22,200 feet). Our plan was to ascend to the Zemu gap, descend to near the Guicha La on the south flank of Kangchenjunga, force a pass to the Passanram glacier, and return to the Green lake over the Simvu saddle. This would make a most interesting circular tour, and is probably not impracticable.

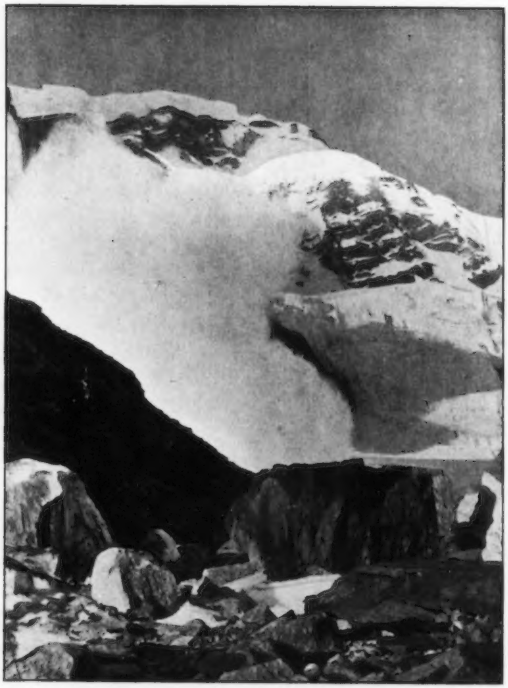
Crossing the Zemu glacier, which looks like a chaotic muddle of moraine heaps rather than a glacier, we camped for the night on a sheltered bank partly covered with dwarf juniper, about 2 miles west of the North Simvu glacier. This was the only place of its kind for many miles, the last outpost of plant life in that wilderness of rock and snow. Next day we proceeded to an altitude of about 18,200 feet in the Zemu gap. Our route at first lay up the east side of the Zemu gap glacier. Towards three o'clock we found ourselves forced on to the side of Simvu by crevasses, and others barred further progress in front. A traverse to the right and short ascent showed us that all the crevasses had been turned, and that the remaining 1100 feet should present no difficulty. The night was bitterly cold, with wind and drifting snow. At 5 a.m. I roused the coolies, but the cold was so intense that they soon rushed back into their tent and cowered together. On my protesting, they declared it impossible to do anything in such cold, and that we would have to wait until the sun reached the tents. This would not occur until between 9 and 10 o'clock, as the sun would have to rise above a lofty buttress of Simvu. The manœuvre of retreating to their tent was repeated a second and third time, and I began to lose patience. It should be explained that they had

been given on the preceding night two large down quilts, so that they were as well protected as myself—I did not use a sleeping-bag—and they were wearing quite as much clothing. Eventually we got away about 8.30 a.m. just as banks of mist began to sail up the Zemu glacier. Going at full speed, and halting only once for a few minutes, we reached the top of the gap (19,300 feet) about 9.30 a.m., our pace being considerably over 1000 feet per hour. The going would have been very easy had it not been for 6 inches of snow which had fallen in the night, and in places blown into wreaths. Half an hour before we reached the top, however, grey mists were sweeping through it, and from the summit, which was only a few yards across, the view was spoilt. An icy wind blew through the gap, and it snowed intermittently. The slope fell away steeply in front, and a few yards down there was a crevasse which stretched right across the gulley.

After waiting for an hour in the usual freezing blast which comes through such gaps—only rewarded by a glimpse of a great white peak (presumably Pandim) through a rent in the clouds—as it seemed too hazardous to attempt a descent with heavily-laden coolies through mist, we retreated and proceeded to our old camping-place near the Simvu glacier. On the way the view of the crags of Kangchenjunga was very imposing, and we noted that the north-east buttress seemed almost inaccessible, and would, in fact, require difficult climbing to get properly on to it, as it degenerates into a narrow rock ridge which rises at the end into a small peak. On the following day we ascended to the summit of the Simvu saddle (17,700 feet). The climb was merely a walk along the west side of the Simvu glacier, and could have been made the whole way unroped. At the bottom of the glacier, about 1½ hours from our previous camping-place, the coolies wanted to halt for the night, promising to start at 4 a.m. next morning. Referring to their behaviour on the previous day at the Zemu gap, I jokingly suggested that it was not 4 a.m. they meant, but 10 a.m., whereupon they laughed good naturedly, and we went on to the summit. This incident indicates one secret of how to deal successfully with coolies, who have a weakness for wanting to camp about an hour after starting in the morning. Mist was sweeping up from the south when we reached the top at 3 p.m. The descent was much steeper in that direction than to the north, and was blocked by an icefall about 250 yards down. We camped about 100 yards from the icefall. Towards evening the mists cleared except to the south, and there was a magnificent sunset over Simvu and the crest of Siniolchum. The west side of the latter mountain is very precipitous, but may not be quite impossible.

On the following morning we carefully surveyed the icefall, and came to the conclusion that it was practicable for a roped party of loaded coolies, but that great care would be required, especially on the descent. The pass leads to the Talung Chu, one of the westerly affluents of the Tista. It would be possible by means of this pass to reach Jongri, the

PANORAMA (140°) LOOKING INTO TIBET FROM THE SUMMIT ARÊTE OF CHUMIUMO (22,430 FEET).



AN AVALANCHE FROM THE OUTLIER (22,500 FEET).

THE EASTERN FACE OF CHUMIUMO (22,430 FEET) FROM NEAR GIAGONG.

Kang La, and Phallut on the eastern border of Nepal, or, proceeding down the Talung Chu, Gangtok, the capital of Sikkim. Fine views were obtained from the summit both to the north and south, but the latter direction was quickly obscured by mist. We unfortunately had not enough provisions to descend the icefall, cross a ridge, and attack the Zemu gap from the south, as one would have liked. The weather, too, was stormy, and we therefore decided to cross the Tent Peak pass, and join our other party in Lhonak. The afternoon of the following day found us camped on the summit of Tent Peak pass. The route is quite easy. On the final ascent to the pass there are several large crevasses, so that coolies must be roped. We had intended to join Tandook that night, but the weather being bad we camped on the summit (19,000 feet), so as to get photographs on the following morning. Snow fell at intervals during the night and continued next morning. While we waited patiently for the mists to lift, three coolies of Tandook's section came up to remove some baggage we found on the pass. They informed us that Tandook was camped 2 miles to the north.

After waiting till the afternoon, as snow continued to fall under the influence of the southerly wind, while sunshine prevailed to the north, we descended the easy snow slope, crossed a glacier and the ridge beyond, and joined Tandook near a small lake. On the way we had to cross a glacier, and in trying to find a passage over a rapid icy stream on this glacier I slipped in up to the waist, owing to the bank giving way. Fortunately, I managed to scramble out unaided. Another couple of feet would have taken me into water at least 10 feet deep, running like a mill race. The incident is only worth mentioning because there were delays afterwards with other streams, so that an attack of mountain lassitude from which I suffered for the following two days may have been due to waiting about in wet and freezing clothes. The lassitude showed itself in a disinclination to strenuous exertion, and breathlessness in ascending the small hills round the camp, although the height was only about 17,700 feet. The gaps leading into Nepal were examined, as our original intention had been to cross the Langpo gap south of the Langpo peak and investigate the south side of the Jonsong peak. This gap, although practicable for a roped party, was not suitable for coolies. At least that was our conclusion at the time, but from later experience, as detailed below, I believe coolies could cross it with some difficulty.

On the afternoon of May 18 the camp was moved down beyond the end of the north-east Langpo glacier, which stretches further to the north-east than represented in Prof. Garwood's map, and on the following day, after crossing a ridge and passing a small lake, we camped in the afternoon by the Langpo Chu, just at the bottom of the descent from the Chorten Nima La. As the day was early, coolies were sent back to near Tent Peak pass to bring up the rest of our baggage, and with three coolies we ascended the great glacier bank on to the plateau which leads to the south ascent of the pass. This bank presumably formed the left boundary of a huge

glacier which in old times covered western Lhonak. Next day we crossed the pass (18,500 feet), getting a magnificent view from the summit. Our intention was to ascend the fine peak which guards the pass on the east, and which I have provisionally named "Sentinel peak."

About 7.30 a.m. on May 21, we started on the ascent. Our route lay chiefly up toilsome scree slopes for about 1500 feet, when we reached a crevassed snow slope. From the moment we reached snow we had to cut steps, although it was only *névé*. Very soon we were stopped by a wide crevasse, but on traversing horizontally for about 200 yards, we found a narrow bridge, and after that there was little difficulty. First we proceeded south towards what looked like the summit, but near this another higher summit appeared on the left. On reaching this, however, we found it to be merely the heavily corniced edge of a precipice which plunged down to a large glacier on the east, and a third summit appeared as a sharp snow-peak right in front. It was now about 1.30 p.m., and the coolies were discouraged. Tuny, who had cut steps the whole way, confessed to being exhausted, and Sona was pessimistic as usual, but after a rest they agreed to come up to the top. Unfortunately, a small portion of the *arête* was green ice, and necessitated careful step-cutting, so that it was past three before we reached the summit (about 22,000 feet), which has probably not been triangulated, but may be the peak named as 22,060 feet, and misplaced on map. The last portion was soft new snow, the slopes on each side being steep. It was misty and snowing when we reached the top, and after a halt of only a few minutes we began to descend, when the mist was blown aside and we got a fine view. It appeared that we had been at the end of a nearly horizontal narrow crest, but whether the other end was a few feet higher or lower I was unable to make out. It was obvious that glaciers occupied the defiles to both east and west instead of rivers as marked on the map. Mr. Freshfield has already pointed out how inadequately the Himalayan glaciers have been treated in the survey maps, and from what we saw here and in other places near the southern boundary of Tibet, the area under glaciers as represented in the latest map of Sikkim (1906), showing adjacent parts of Nepal and Tibet, should be nearly doubled.

After a rapid descent we arrived at our camp about 5.30 p.m. On the following morning we recrossed the Chorten Nima La and joined the main camp.

Next day found us on our way to the Jonsong La (20,300 feet, traversed by Mr. Freshfield's party in 1899), which was crossed on the following day, and our camp pitched at about 19,000 feet near the south Langpo glacier. From this position we had in 1909 ascended the Langpo gap and also the Langpo peak. Our present intention was to repeat the ascent of the Langpo peak, which was particularly easy in 1909, and from the top decide on a route up the Jonsong peak (24,400 feet), and more especially to investigate the summit *arête* of that mountain.

In August, 1909, the ascent of the Langpo peak was similar as regards difficulty to that of the Zermatt Breithorn from the Leichenbratter hut, with the exception that the last 600 feet was steeper than anything on the Breithorn. From the denuded appearance of the mountain, as seen from the Jonsong La—there is more snow below and less snow above 19,000 feet in May as compared with August—we were afraid that the final 1000 feet might be icy and difficult. This proved to be the case. The mountain at this early season of the year was considerably more difficult than the Finsteraarhorn *viâ* the Hugi Sattel, and we failed to reach the top.

During and after our attack on the Langpo peak the weather continued bad for several days, mist enveloping our camp a great portion of the time. Our next step was to descend the south Jonsong glacier, and turn north-west up a glacier provisionally named Long Ridge glacier from the mountain on the west. A pass at the north end of this mountain looked easy, but, on investigation on the following day, was found to be of the writing-desk type—an easy slope to the east and a fairly sharp precipice to the west. When we were on the summit of the pass the coolies pronounced the descent impossible, but on the following morning, after a little persuasion, three coolies agreed to come with me and attempt it.

Our intention was to cross Long Ridge pass (19,520 feet) and proceed west until we could find a way over the Chabuk La or some other pass to the north-west, and then return into Lhonak by the Chorten Nima La. We would by so doing get a proper estimate of the Jonsong massif, and ascertain whether any attack on the Jonsong peak was possible from the south-west. Our main object, however, was to find out the relationship of the lofty range which we felt convinced prevented the Mount Everest, Chomokankar, or Chomo Langmo group from being clearly seen from this portion of the range.

The ascent of the pass was not difficult, although there were several awkward crevasses. The descent was, however, very steep, probably at least an angle of 60° to 70°, and was made unroped, the coolies greatly preferring that arrangement; the rope would have been cut to pieces on the sharp rocks, so that I was quite agreeable. A stone tossed from the summit would have fallen on snow 500 feet below. A few small gullies filled with glassy ice were troublesome, requiring careful step cutting. After descending we crossed a glacier and camped on rocks about a mile to the west, under the precipices of a sharp isolated peak of the Jonsong group which we have provisionally named "the Outlier." It is probably about 22,500 feet high. From our camp we had a magnificent view of the north-west face of the redoubtable Jannu (25,310 feet), which looked like a great cathedral with twin towers.

Next morning we proceeded along the glacier, which ended abruptly in the most peculiar way at a corniced edge to a precipitous descent leading down to a glacier about 1500 feet below us. It was a regular "cut-off," and a discussion and delay followed. We had not expected anything of

the kind. The route seemed impassable for laden coolies in front, and the head of the glacier below us was barred by cliffs. Beyond the great trench in front was an array of peaks and passes. The coolies asked me point blank which was the Chabuk La, and I had to confess that I did not know. We had only two days' provisions, and were probably at least four days from the Chorten Nima La by that route. The map was hopelessly wrong, showing the unknown marvel of a river flowing in at the head of a glacier as being in front of us. The person who mapped this portion of the range seems to have been mentally related to the "scientist" mentioned in Mr. Freshfield's 'Caucasus,' who undertook to prove that there were no glaciers at all in the Himalaya.* To advance further with heavily laden coolies seemed unfair to them, but I regret now that we did not seek another route of descent and make the attempt. We could have hidden some of our baggage and sent back for it if necessary, but the idea did not occur to me until it was too late. As usual the weather gave the casting vote, so to speak. The clouds which had been massing round Jannu all the morning blew up with astonishing rapidity, and it began to snow. Reluctantly the order to retreat was given, and we returned to our old camp. In the afternoon a fine avalanche fell from "the Outlier," which I was fortunately able to photograph. The clouds of snow dust look like mist.

On the following morning we recrossed Long Ridge pass and reached our old camp by the Langpo glacier, and next day, crossing the Jonsong La, we reached Tandook's camp, at the foot of the slope leading to the Chorten Nima La. Taking two fresh coolies, two days afterwards we were at Thango, having crossed the Lungnak La (17,300 feet).

It must be pointed out that what we saw from Long Ridge pass conclusively proves that the Pandit Chandra Das must have crossed the Jonsong La, although he describes it under the name of the Chatang La. Prof. Garwood's adverse criticism of the Pandit's description of the route is probably due to his having passed over the ground in the reverse direction under different conditions. The pandit's description of his route from Ramthang northwards is correct, except as regards compass directions. The portion of the path mentioned as being among boulders is about 2 miles north of Pangperma, and the seracs referred to are those at the confluence of the south Langpo and Jonsong glaciers.

At Thango the party divided. Coolies were sent to Darjeeling and into Tibet for supplies, and four coolies with two yaks to carry wood came with me to attempt Pawhunri, a mountain on the north-east frontier of Sikkim.

Proceeding to Giagong and the Tso Lhamo (Lake of the Goddess), we reached the snow-level at 18,000 feet on the third day. Here one of the

* Presumably this portion of the chain was sketched from the indications of one of the native Pandits, whose drawing has been shown me by Mr. Freshfield.

yaks—aided and abetted by its owner—refused, like a sensible animal, to come further, so that we had perforce to camp early. On the following day an ascent to 20,700 feet was made, but we were driven back by a high wind which whirled the fine surface snow into dense clouds. The camp was next moved up to 20,000 feet, and on the following day we reached the summit, 23,180 feet. The view was unfortunately spoiled by clouds beneath us, but was nevertheless interesting. West and south nearly everything was obscured by a rolling sea of mist, above which some of the great peaks, Kangchenjunga, Chumiumo, and the Kangchenjhau, showed their crests like rocky islands. About 4 miles to the east was an accessible snow peak, about 23,000 feet high, and between us and it there flowed northwards a fine glacier, and not a river as marked on the map. On the way up we had glimpses of the north end of the Chomolari range, but the most interesting view of all was two lofty snow peaks bearing east-north-east about 100 miles off, which towered up above the horizon in a most imposing manner. Only snow was visible and must have represented about 6000 feet, which would make the mountains at least about 25,000 feet high. They seemed to be distinctly north of the main chain. Mist covered them before we reached the top. We took nearly six hours to ascend, but did not hurry. Keeping close to the edge of the western cliffs until about 1000 feet from the top, we then made a bee line for the summit through snow nearly a foot deep.

The summit was corniced to the east, and was some distance from and much higher than the tops of the western cliffs. We remained on the top about 35 minutes. We felt quite comfortable except for the cold wind, and I am confident that there would have been no difficulty in carrying out moderately complicated experiments, such as estimating the number of the red and white corpuscles in the blood. This is specifically mentioned because authorities have stated that such estimations would probably be impossible above 17,000 feet. Samples of air were taken, and estimations of carbon dioxide started.

Had we brought a spade with us, we might have dug a big hole on the top and brought up a tent next day to carry out some experiments, and get photographs. It was quite hopeless to think of pitching a tent unless we had some protection from the wind. The descent took us about two hours and a half, but we did not descend nearly so quickly as in 1909, when we only took about two hours between 23,000 feet and a camp at 18,500 feet.

During the ascent I carefully compared the climbing capacity of the two coolies with me—Sona and Tuny's brother—with my own, and found that they climbed much better, especially above 22,500 feet. Above that elevation they could have given me at least 300 feet in 1000 feet; that is to say, they were at least 30 per cent. better although they were lightly loaded. In 1909 (when 23,000 feet was reached) the two coolies with me seemed only slightly better than myself, but they were weaker than Sona or Tuny's brother.

This comparison of the white man with the native has some interest, and perhaps one might take this opportunity of succinctly stating the results of our experience in three visits to these mountains.

At any height up to 15,000 to 17,000 feet one could hold one's own with the unloaded coolie and easily beat the loaded man. Above 17,000 feet, however, their superiority was marked, an unloaded coolie climbing much quicker than myself, and even a moderately loaded coolie going up as fast as one cared to go, up to 21,000 to 22,000 feet. Above that elevation a moderately loaded coolie could run away from me, and with an unloaded coolie one had not the slightest chance.

Why should there be this distinct difference in acclimatization to high levels between white men and Indian mountaineers, and is the difference universal? I venture to think that Mr. Freshfield, Prof. Collie, Dr. Longstaff, and Mr. Mumm would agree with me so far as their experience goes. The Brocherels might, however, be taken as exceptions to the rule according to Dr. Longstaff's narrative of their behaviour on Gurla Mandhata and Trisul.

I have only had experience of two professional guides (Swiss) in the Himalaya, and they were more adversely affected by elevation than myself. It is not impossible that people accustomed from childhood to pressures of three-quarter atmosphere or less may either require less oxygen, or may have greater lung capacity. A little more will be said about this interesting subject—the effect of elevation—later.

It might be mentioned that at the camp, at 20,000 feet, estimations of blood-corpuscles (blood counts) were made without difficulty, but I confess that it required a considerable mental effort to bring oneself to carry out the experiments. One felt as if there was an extraordinary inertia to be overcome. There was also a peculiar tired feeling which increased in intensity with altitude. As we toiled up the last 1000 feet of Pawhunri, I recollect that it occurred to me that at last I probably understood in some measure the feelings of that mysterious class of people who are "born tired." I remember, too, that it afforded me some amusement to reason by analogy that as my tired feeling was due to altitude, and a descent of a few thousand feet would render me nearly normal, probably people who are born tired might possibly feel inclined to work at the bottom of a particularly deep mine, or in a caisson under high pressure. It occurred to me, also, that they should be examined medically to see whether they did not require instruction in respiration.

On descending to the desolate sandy flats at the base of the mountain, one is struck by the remarkable variety of wild life which may be met with. A herd of eight kiang passed quite close to us. Several types of wild birds were met with about the Tso Lhamo, including eagles, pheasants, and two pairs of handsome brown geese with black and white wings. Later on, we saw on the way to Chumiumo another half-dozen pairs of these geese, but we only saw one young one, of which the parent

PANORAMA (142°) OF THE NORTH-EAST JONSONG GLACIER (LHONAK GLACIER), SHOWING TH

WING THE JONSONG PEAK (24,400).

Jonsong Peak.

birds seemed very careful. It made one annoyed to think that a certain type of gunner—one does not mean sportsman—could easily have exterminated all these geese, for they were quite easily accessible.

There was an extraordinary number of small birds, of which the commonest was a species of lark (*Melano-corypha maxima*), which must have been there in hundreds. We found four nests without looking for them, one with three young ones, two with two, and the fourth with two brownish eggs. The young ones differed in many respects from the older birds, which had a peculiar black collar. These larks began to sing before 4 a.m., apparently quite irrespective of sunrise, for there was no trace of the sun until at least an hour later. When one went near their nests their pleasant warbling was changed to a characteristic plaintive note, which no one could fail to recognize. Quite unwittingly we erected our tents about 3 yards from a nest. From the plaintive notes heard after we had settled down, I was sure that we must be trespassing, and, on looking, found the nest with two young ones. I was inclined to move the tents, as I was afraid they would starve, but in a short time one of the birds came to feed them, and continued to do so at intervals of a few minutes during the afternoon and next morning. Deer, hares, and little creatures like marmots were also seen.

We found the whole of this trans-Himalayan portion of Sikkim in the hands of Tibetans. There were four large black tents and many smaller ones, the number of Tibetans being about 50. The people were friendly, and men, women, and children were quite pleased to be photographed. These Tibetans were well off, and owned at least 2000 sheep and 150 to 200 yaks. It seemed somewhat an anomaly that while these people were given free entry into Sikkim, no white man was allowed to set foot in Tibet.

On the way back to Thango we met Mr. Bell, the British resident from Gangtok, who was most kind and hospitable. He was much interested in the report of the existence of lofty snow-peaks to the east-north-east, which he suggested were part of the Kuhla Kangri mountains. He had seen the south of Kuhla Kangri from Bhutan, but his account did not agree with the two peaks seen, which were probably about 12 miles apart and different in appearance. On asking Mr. Bell whether it would be possible to investigate the peaks from Bhutan, he stated that that country was quite closed to white men at present.

The weather continued so broken towards the end of June that we had to give up our intentions of attacking the Jongsong peak, and turn our attention to Kangchenjhau (22,700 feet) and Chumiumo (22,430 feet). On the way back from Pawhunri we had examined the north face of the former mountain as far as mist would permit, but could see no good way leading to the summit. The mountain had never been clear, however, even in the early morning. In order to investigate the south side we determined to ascend the Sebu La (17,600 feet), and started on June 22.

We had the pleasure of Mr. Bell's company for part of the way. The whole of Kangchenjhau was never visible at one time, but enough was seen to show that the mountain was practicable by a long icefall which started east of the main peak and curved round towards the south-west. It was impossible, however, to climb the mountain in the circumstances, because the relationships of the crevasses were complicated, and the possible route was only visible for a few minutes in the morning. It was therefore decided to cross the Sebu La and attempt Tsen Gui Kang, a fine peak 21,000 feet high which we had admired from Mome Samdong in 1909.

On June 23 we crossed the pass, and camped at about 17,000 feet, not far from a small ice-covered lakelet. On the ascent we met with large numbers of plants of the mountain rhubarb. The coolies seemed to appreciate them greatly, and gathered large quantities. I tried them, but found them somewhat insipid, and with none of the sourness of the cultivated plant. As, however, fresh vegetables had been very scarce, I asked Sona to cook some and serve with tapioca at dinner. In this form it was more palatable, but I am inclined to think contributed somewhat to insomnia and a peculiar intermittent throbbing in the cerebellar region, which occurred every few minutes for some hours.

It was about two o'clock when we reached the snow on the pass, and to my surprise the coolies were most unwilling to cross. They declared the snow far too soft, and I had to ascend alone nearly three-fourths of the entire distance to the summit before they started to follow. Having a rather hazy idea of the proper route, I went quite close to a few small crevasses which might easily cause trouble to an unroped party. I found later that these small crevasses are specially mentioned by Mr. Claude White in his book on 'Sikkim and Bhutan.' It snowed or rained nearly the whole of the day and two nights spent near Sebu lake, and as the crests of Tsen Gui Kang and Kangchenjhau remained obstinately in the mist we moved back to Thango. Here followed an awkward delay, because a portion of our party had not returned.

As our defaulters did not come in, and the weather continued bad, it was determined to make a serious attack on Chumiumo, the only mountain which might now and again be out of the mists. The coolies were somewhat discouraged on starting, as they declared that the Lachen men said that Chumiumo was impossible. They brightened up on being assured that there was no intention of clambering up the precipices which form the east and south sides of the mountain which they had already seen, and that the west side, when examined from a distance, seemed not at all difficult. Coolies have a very keen sense of the value of their lives, and dislike being taken into places even approximately dangerous.

Crossing the Lungnak La in heavy rain, we proceeded along by the Naku Chu, passing the ruins of an old Tibetan fort (Dzong) on the way. There were some fine herds of yaks in this valley. The evening of the

fourth day found us encamped on the south-west escarpment of Chumiumo under towering precipices. We found that Chumiumo was certainly possible from the south-west, but that the north-west *arête* looked much easier. Mist was almost continuous, and snow fell at intervals. This incessant moisture seemed to affect the rocks, and falls were more frequent than I have ever known them. Some tremendous rock avalanches fell from the precipices of the south face.

As our tents on the rocks were more exposed to the dangers of falling stones than is allowable for moderately orthodox climbers, and as the weather seemed much better a couple of miles to the north, we moved our camp round to the north-west face of the mountain. We camped near a beautiful clear stream of water flowing from a small glacier at 18,500 feet, and next day moved our camp up to 19,500 feet, camping on rocks which obviously contained a large quantity of copper. Although only about 2 miles in a direct line from our old camp at the end of the south-west *arête*, and in a similar position—namely, on rocks near precipices—the weather was quite different. Rockfalls were very rare, and the mist never came down to our level. As indicating the height to which the waves of the sea of animal life may reach, it is worth mentioning that a few delightful little rock warblers had built their nests at nearly 20,000 feet, on the rocks above our camp. They seemed quite fearless of man.

The south end of the mountain remained obstinately in mist, while the north end was fairly clear, and we looked over a large portion of Tibet. Tuny arrived from Thango on the evening before we made our attempt, along with Anderkyow, who had been sent for provisions. He reported that Tandook had returned with supplies.

On July 12 we started at 6.30 a.m. The morning was doubtful. Ascending to near the head of the glacier, we crossed, and went up to the right of some seracs which nearly touch the north-west rock *arête*. At a height of a little over 20,000 feet, near the base of the final ascent, were a few awkward crevasses, but after passing these the mountain was surprisingly easy. Tuny and Sona wished to try the north-west rock *arête*, but I insisted on trying the snow, which, although steep, was in excellent order, and probably took not more than a third of the time that the rocks would have taken. I mention this because the coolies always baulked from steep snow, being under the impression that it was dangerous. We arrived on the summit *arête* in mist, and had to wait for some time before the north top loomed up about 200 yards off. Ascending to this top, which is only a couple of yards broad, and appears as a sharp snow peak, we halted until the mist lifted somewhat, and then proceeded along the *arête* to the south summit, which is about 300 feet higher. It was a beautiful walk without the slightest difficulty, although in places the way was narrow and we were quite close to the edge of the formidable eastern precipices. The snow was never more than a foot deep. The south top is bounded on the south and east by precipices, but is several yards broad

and quite safe. We remained for about half an hour on the summit (22,430 feet), and then proceeded back by the way we had come. Mist had interfered greatly with our views from the top, but fortunately we managed to get some photographs, and we took others while proceeding along the *arête*. We were back in camp about four o'clock, after a day which impressed us all by its easiness. On the return journey the snow on the steep slopes was in good condition, but near the crevasses at the bottom was so soft that we sank repeatedly nearly to the waist. We frequently stuck, and had to extricate each other with ice-axes, the snow freezing suddenly just above the knee, so as to render movement of the leg impossible.

Sona and Tuny did not seem to be much affected by the elevation, while I felt that I could have climbed considerably higher. Whether this was due to a rest the day before, or to my becoming acclimatized to high altitudes, is somewhat difficult to decide. Probably both factors contributed, especially the latter. One of the main difficulties at high altitudes depends on the fact that one does not breathe rapidly enough to oxygenate one's blood sufficiently, and it is only after some weeks that one seems to be able to accustom oneself to breathing faster, which makes a great difference to one's comfort in climbing.

Next day we proceeded to Thango, a fairly long day's march. We crossed the north Chumiumo glacier, and, ascending the ridge to the east, descended to the pony track which proceeds north from Lachen to Kamba Dzong. From the summit of the ridge (about 20,000 feet), a superb view was obtained of the mountains stretching away to the west. What we had suspected before became clearly evident, namely, that on the east side of the Arun river there are several lofty peaks, which would almost certainly hide the Mount Everest group from any traveller on the mountains of North Sikkim, unless from view points over 21,000 feet high. The highest of the range, which is called Kanglingen, appears as a massive snow peak, and must be over 23,000 feet high. Near it a route leads from Saar over an easy pass called the Tok Tok La to the Arun river. We are, therefore, nearly sure that Mr. Claude White and others are in error when they state that they had good views of the Mount Everest group from positions on or near the mountains of North Sikkim. It is probable that on very clear days the loftier peaks may show over the Kanglingen group, but they could hardly be very conspicuous. Observers may have confused the two groups.

As we would have had to wait at Thango for at least a fortnight before the weather was good enough to guarantee a satisfactory view from the summit of the Jonsong peak, we decided to go round to the other side of Nepal and make an attempt upon Kamet (25,400 feet). This was not a judicious decision, as our time was too limited. Darjeeling was reached on July 25, and here we bade farewell to the faithful coolies who had accompanied us for about three months. In order to prevent misunderstanding, I must state that all of these men were in the best of health and

spirits. They were thoroughly satisfied with food and pay and the amount of work expected of them, and when asked at Thango whether they would remain for another month if we decided to attempt the Jonsong peak and the Kangchenjhau, every one of them volunteered to stay without hesitation. These Sherpa Nepalese coolies are, in fact, most agreeable to work with, and if treated kindly, will do anything reasonable.

Taking Tuny and Sona with us, we left Darjeeling on July 27, and three days afterwards arrived at the railway terminus of Katgodam, where our route joins that taken by Messrs. Mumm, Longstaff, and Bruce in 1905. Any one wishing to get a good idea of Kumaon and Garhwal cannot do better than read Mr. Mumm's book. On the third day from Katgodam we reached Almora, the capital of Kumaon. The deputy commissioner was absent, but the assistant deputy commissioner was most obliging and gave me a note to the Tashildhar, who threw himself into the business of getting coolies with a most praiseworthy energy. Within half an hour two sets of seven coolies each were paraded for inspection. I wished to select a few from each batch, but was informed that no one of the first batch shown would travel with any of the second because of caste prejudice. The men selected were quite different in physique from the Sherpa Nepalese coolies, being tall and slim, and their stamina was found to be inferior. They would only carry about two-thirds of the loads taken by the Sherpas, but they agreed to come through to Badrinath, about ten days' journey by the Kuari La. This was the first time that any arrangement of the kind had been entered into, and it worked well. The coolies required more encouragement than the Nepalese coolies, and being Hindoos, preferred to be paid cash for food. Any white man or Buddhist like Sona and Tuny touching their food would spoil it. I therefore left them entirely to themselves when at meals. The unconscionable time they took to breakfast—about three hours—during the first few days caused me to make inquiries. I found that they had only one small griddle pan between the seven of them, and that each of them used it for cooking ten to twelve chupatties in rotation.

The first three days' march from Almora to Gwaldam was very hot, and we were told the monsoon had failed, but at Gwaldam we entered what seemed to be a region of continual rain. For the next six days we pushed on through torrents of rain and dank and dripping forests to Joshimath We generally camped on the path and trenched our tents thoroughly. At Joshimath we met with a surprise and disappointment. The patwari, or local magistrate, called with a letter from Mr. Stowell, the Deputy Commissioner, prohibiting further advance, and threatening legal action if we proceeded. After telegraphing twice, and losing a day, we were allowed to advance to Badrinath.

After two days' holiday for the benefit of the Almora men, we proceeded northwards with fifteen coolies, and the second afternoon found us encamped at the end of the Khaiam valley. The coolies here quite misled

me, insisting that this valley afforded the best way to Kamet, whereas we should have taken the Khati (or Gastoli) valley to the south. We found these Mana men most unreliable as regards information, and would never again trust them. The geographical sense of many coolies is somewhat feebly developed. We pushed a camp up to 18,500 feet, and on the following morning were fortunate enough to get a magnificent view of Kamet and attendant peaks. Kamet looked impossible from the west, but it might be practicable to ascend a steep slope of snow to the south of the peak, and bend round on to the north-east face, which looks the most probable direction for a successful ascent. We climbed a small snow peak about 20,200 feet high to the north of the pass, but the mists had covered Kamet before we got to the top, and little further was learned. It was obvious that we had not time to attack Kamet seriously, so that Tuny and the Almora men were despatched homewards, while Sona and I, with three coolies, proceeded north towards the Mana pass leading into Tibet. On the morning of the third day Dhoneran peak, a long easy mountain about 19,000 feet high, was climbed.

From the summit we had a fine view of the north-west face of Kamet. This face looks practicable if one could get on to it. The arrangement of the gorges to the north-west of Kamet is probably incorrectly given on the map, and would repay investigation. If we had only had another fortnight! It was, however, imperative that we started for Bombay. Our Almora men were already three days' march ahead of us. A strenuous effort was therefore necessary, and we moved rapidly southwards by double marches, covering over 40 miles in the first two days.

Before concluding, perhaps a small contribution might be made here to the already voluminous literature on that debateable subject, the so-called mountain sickness. From our experience the alternative term "mountain lassitude," first introduced by Major Bruce and subsequently endorsed by Dr. Longstaff, is a much more satisfactory term. None of our party were in the slightest degree sick at high altitudes, and the climbing powers of the strongest coolies seemed to be only slightly affected even at 23,000 feet. Elevation in the case of a normal individual simply reduces their vitality and strength, and therefore capacity for resistance to the onset of sickness, which, when met with, is chiefly due to other more active factors. Elevation is essentially a predisposing factor rather than an active one, its effect probably depending upon diminished formation of oxyhæmoglobin during respiration.

The other factors, which, when aided by elevation, tend to upset one's capacity for keeping all the organs in the proper co-ordination which we call health, might be summarized as follows: 1. Inadequate training. 2. Indigestion due to unsuitable food. 3. Over-strenuous exertion. 4. Want of acclimatization to high altitudes. 5. Exhaustion. 6. Psychic effects. 7. High temperature. 8. Chill. 9. Snow glare. 10 Advancing age.

1. *Inadequate Training.*—This is serious in the Alps, but much more potent in the Himalaya.

2. *Indigestion due to Unsuitable Food.*—The best possible diets for high altitudes have yet to be devised. There is probably no doubt that the appetite is lessened. After long and careful experiment, we found that the best mainstay of both morning and evening meal was a large bowl of soup, thickened with rice and with added butter. The three ingredients were served separately. One could then add tongue, boneless sardines, etc., as wanted; but it was found that the entire elimination of meat by substitution of four or five freshly made chupatties (unleavened pancakes) with jam and butter was occasionally a good plan. Of course, different men require different diets, so that one must not be dogmatic.

We carried several tins of plasmon with us for use on an ascent of the Jonsong peak or Kamet, if opportunity offered, but unfortunately had no opportunity of testing them.

Perhaps peptonized foods and prepared substances containing glycerophosphates like sanatogen might be useful for protracted camps at heights over 23,000 feet. Hot tea in thermos flasks we found excellent at high altitudes, but the two flasks taken were broken within a month. Failing tea Prof Collie informs me that citrate of caffeine is an excellent substitute.

3. *Overstrain.*—Over-strenuous exertion is a frequent cause of real sickness, because the co-ordination of the different organs is rendered far more difficult to maintain. It is, therefore, probably better to go slowly, so that in this respect I would venture to disagree with Dr. Longstaff and to follow Mr. Mumm, who says, "Camp high and start late." I would prefer to read this, "Camp high and start as early as you safely can."

4. *Want of Acclimatization to High Altitudes.*—In attacking very lofty peaks it would probably be found advisable above 20,000 feet high to push camps up only from 1000 to 3000 feet per day, depending upon difficulties met with.*

5. *Exhaustion.*—When one is near the limit of one's powers, especially when fasting, the waste products thrown into the blood are beyond the possibility of natural elemination, and toxic effects are produced.

6. *Psychic Effects.*—These might be important, especially in the case of a beginner finding a place more dangerous than anticipated. Probably local blood congestion supervenes—perhaps splanchnic dilatation or constriction—which has a deleterious effect.

7. *High Temperature*, 8. *Chill*, and 9. *Snow Glare* vary greatly in their effects. They are indefinite factors which tend to upset the co-ordinating balance.

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* The idea that the bad effects of high altitude are cumulative is, we think, completely negatived by the ease with which, at the end of the expedition, we climbed Dhonerau peak (19,000 feet), marched about 20 miles, and then made 22 miles next day. In 1909 we also made about 40 miles in the first two days' marches when retreating from the mountains, after prolonged residence above 15,000 feet.

10. *Advancing age* is, like elevation itself, a general depressant of one's powers, but when I consider that one of the Vice-Presidents of the Society, when getting towards threescore, led a large party over a pass more than 20,000 feet high into an unknown country, the effect of age is obviously a variable one, and must be greatly discounted in certain cases.

It must not be supposed that the natives are never afflicted with what looks like mountain sickness. I have met with several cases, but usually at comparatively low levels, and in nearly every case the diet was to blame.

Perhaps three facts might be emphasized in conclusion.

1. The ordinary mountaineering rules regarding use of ropes, etc., should be carefully followed in the Himalaya, even in the case of snow passes used by natives, unless the position of crevasses is known. This is especially important before the summer snows begin, as numberless crevasses are then thinly covered. Exceptions are made in the case of moraine-covered ice streams like the Zemu and Kangchenjunga glaciers.

2. Men with cloth boots should not be taken on dangerous ice slopes, and especially ice traverses. This follows from what has been related above, and is confirmed by the experience of Prof. Collie in Kashmir.

3. Many of the Sherpa Nepalese are firstrate climbers as well as coolies, and could be used for serious climbing of the big peaks like Kangchenjunga, after proper training. Serious climbing in the Himalaya can hardly be said to have begun, but I might venture to express agreement with Mr. Freshfield's dictum, that all the great peaks can and will be climbed.

I must take this opportunity of thanking Mr. Claude White for kind help given in 1907 during my first visit to Sikkim, and also Mr. Bell, the present Resident at Gangtok.

Mr. Douglas Freshfield, Vice-President (before the paper): I must express the regret which I feel myself, and which you will all share, that our President is not able to be here to-night. We feel this regret the more on account of the nature of the paper before us—one on Himalayan exploration. Lord Curzon has always taken the deepest interest in Himalayan exploration, and when in office in India, he did all he could to further it, as far as the limited powers of a Viceroy extend. I quality the phrase because the energies of a Viceroy are liable to be hampered by political considerations, and by the scruples of native states. The paper we are going to hear to-night is on that part of the Himalaya which is comprised in the native state of Sikkim, lying some 400 miles almost directly north of Calcutta. It was first brought before the notice of the English public by Sir Joseph Hooker, in his charming work, 'Himalayan Journals,' published some sixty years ago. Twenty-five years ago a young Oxonian, Mr. Graham, described some remarkable climbs in this region. His story was largely discredited, partly through his own fault, for he was a very careless writer, but mainly because at that time many people could not conceive it possible that even trained mountaineers could climb at the pace he described—that is, at about 650 vertical feet an hour above 22,000 feet. It has interested me, in looking over Dr. Kellas's paper, to find that the height he was able to climb at that elevation was 600 vertical feet in the hour, while his native porters

could do more. Then, some five years ago, two Norwegians, Mr. Rubenson and Mr. Monrad Aas, friends of Dr. Nansen, who had never done any mountaineering out of Norway, gained the summit ridge of Kabru, 24,000 feet, the mountain Mr. Graham had ascended, without meeting with any very formidable difficulties. Lastly, twelve years ago, I described here a tour of Kangchenjunga, which was made by my friends Signor V. Sella, Prof. Garwood, and myself in 1899. So far, I have spoken only of papers read before our Society. But there have been other explorers in these mountains. Mr. Claude White, who was for many years Resident at the Native Court of Sikkim, has wandered up and down along the Tibetan frontier. Anglo-Indian surveyors have triangulated the peaks. Native pandits have traversed the passes, and written very entertaining, if not always very intelligible, accounts of them. To-night we are going to listen to a paper by Dr. Kellas, a gentleman who has paid three visits to Sikkim, and made three mountaineering campaigns among its glaciers. He has managed to combine these with his duties as a Professor of Chemistry in this city. He will give us only a very brief summary of some of the results of the last of his visits. There is a great deal too much to be told in a single lecture. But I hope he will bring before us some interesting details with regard to the topography of these ranges, and also with regard to the relations of the great storehouses of snow which feed their glaciers. He may also be able to give us information with regard to the means that should be taken to counteract the effects of altitude on the human frame, and thereby to facilitate the conquest of the highest mountains of the world. If we listen carefully to what he tells us, we shall gather incidentally that he has been to the top of two mountains of over 22,000 feet and one of 23,180 feet. I say, if we listen carefully, because Dr. Kellas's modesty leads him to treat these matters quite parenthetically, and not to dwell upon them in the way in which you would expect an average traveller to do. I am afraid, also, you will hardly gather from his narrative a full idea of the difficulties and dangers of his Himalayan explorations. If he seems to move smoothly from height to height, you must recollect that he probably leaves out sundry dangers, and that by his skill and patience and experience he found the way to avoid others. The Eastern Himalaya are a range which requires considerable skill and mountain experience for its proper exploration, and I cannot recommend it as a field to the Alpine gymnast, who has little acquaintance with the varying conditions in different climates of the upper snows. With these few remarks, I will ask Dr. Kellas to read his paper.

Mr. FRESHFIELD (after the paper): We have all enjoyed Dr. Kellas's very interesting account of a wonderful series of Himalayan experiences. I had hoped that my friend and former companion, Prof. Garwood, would have been here and been able to explain the circumstances under which his map was made. It was only described as a sketch-map, and he did not pretend to give any accurate account of all the recesses of the mountains. This was carefully explained in an accompanying note. He suffered under some exceptional difficulties—first, we had as guide a Pandit who, being very nervous himself of going into Nepal or Tibet, when he thought there was any chance of our getting into either, systematically led us astray; next, there was a premature and very heavy snowfall, which obliterated all the distinctions between glaciers and ordinary slopes. Despite, however, these difficulties, Prof. Garwood has, I believe, succeeded in providing a great advance on any previous map, and a very substantial basis which others may work to perfection. Dr. Kellas's paper, besides its interest as a description of one of the most fascinating portions of the Earth's surface, has a secondary importance. It may, I trust, prove a stepping-stone to higher things. It may be useful, as he has told us, in helping other climbers to deal with the loftier mountains which still remain unclimbed. The

poles have both been discovered, and we must confess that—at least, from the picturesque point of view—they are a disappointment. The North Pole is a speck on the shifting surface of a frozen sea; the South Pole a flat and featureless expanse of snow. Neither provides any natural sign to show the explorer he has arrived; he has to take up his instruments to prove that he is not far from the exact spot; he is unable to leave any permanent record of his visit. Now, it seems to me that the next problem to be attacked, the ascent of the highest mountains of the world, will be a more satisfactory one for those who attack it, because the adventurers who first shake hands on the top of one of the highest Himalayan peaks will have no doubt of their victory. The ascent of the highest mountains of the world is a task that will take money and time and perseverance and technical skill, but it will require less of these than has been required in the conquest of the poles, and it seems to me the reward will be as great, because, though these exploits may seem to belong not so much to science as to the adventure of travel, yet in the end science profits in one way or another. We have practically, in my lifetime, elevated the man-level from 18,000 or 19,000 feet up to nearly 25,000. How it is to be carried up higher Dr. Kellas has suggested to-night. The problem is one which may require time for its solution. But there is a general consent among climbers that it will be solved. Close attention to diet, frequent and light meals, prove the best means to prevent mountain lassitude from developing to an extent that incapacitates from climbing. An Arctic equipment, as light as it can be made, must be provided, both as to tents and clothing. A form of boots that will protect from frostbite, and yet not be dangerous in icesteps, must be evolved. The right season of year for each district must be ascertained; the local orography closely studied. Native coolies must be trained, as they were by Dr. Kellas, to glacier work. Bivouacs must be pushed higher and higher from the base until a light party can hope to climb from the last to the supreme summit. On all these matters Dr. de Filippi's sumptuous record of the Duke of the Abruzzi's recent expedition to the Karakoram supplies the most valuable information, and his conclusions agree, I think, in every respect with those independently formed by English mountaineers.

I am not going to follow Dr. Kellas by furnishing any further hints as to the best way to attack Kangchenjunga; for I am unwilling to do anything that may incite that enterprising body, the Press, to offer a large reward to some one to rush in and race a properly organized expedition. I make this remark not without foundation, for seven years ago a London newspaper sent out a person it described as its "special commissioner" to climb Kangchenjunga. The delegate took with him three Swiss, not Alpine guides, but, I understand, Swiss gentlemen. The party reached the base of the mountain; there one of the Swiss and four coolies perished in the snow! I trust whenever Kangchenjunga is attacked it will be by a properly constituted party; otherwise fresh disasters must be looked for.

Mr. Claude White: I have had very great pleasure in listening to Dr. Kellas's paper to-night, and, although I am no climber myself, I have been to the bottoms of most of the valleys from which Dr. Kellas made his ascents. There is one point that may be of interest, and that is, I found all my coolies and escorts got what I termed "mountain sickness" at a height of about 15,000 feet; I cannot tell you from what cause, but if I got them past that height, I could generally get them up to 19,000 or 20,000 feet. Dr. Kellas is scientific; he may be able to give you some explanation of this.

Mr. A. L. Mumm: I have listened with intense admiration to Dr. Kellas's story, and I have looked with amazement at his photographs, but I think the most amazing thing I have seen this evening is really this map with his route marked upon it.

That brings graphically before one the extraordinary amount of ground he covered in a single season at immense elevations, above ice and snow all the time, crossing passes 19,000 and 20,000 feet high, and ascending peaks of 22,000 and 23,000 feet, in a way which, I believe, has never been paralleled. The first and most obvious reason for his success was his extraordinary energy. He seemed to me to be above all human weaknesses, and I was quite relieved when towards the end of his paper he had to admit being subject to a small extent to mountain-sickness, in the reality of which I have a most profound belief. Next to his own personal energy, I think that the leading cause of his successful achievement was the great skill which he displayed in training and managing his coolies. The same skill in that respect was displayed by Mr. Rubenson, to whom Mr. Freshfield referred, a few years ago, but Dr. Kellas went one better than Mr. Rubenson, who had the support of a skilful European mountaineering companion, whereas Dr. Kellas had to rely solely on himself and the pupils of his own training.

I have no knowledge of Sikkim, and have nothing to add to what Dr. Kellas said about that region; as to Kamet, all I have seen of it was the eastern side, which was the exact opposite to the side he visited. I think two other parties besides Dr. Kellas have approached it since we were there, but none of them has made a really serious attack on it. The fact is, it is from all sides ungetatable. There is one further point with regard to the extraordinary amount of work done by Dr. Kellas. Most travellers who go to new, unexplored parts of the Earth's surface, go once and do not return, and I think all of them come back feeling how much better they could do things next time. They bring away a great deal of experience, which is unfortunately personal and largely incommunicable, and however much the next man may sit at their feet and hear all they have to say, it is impossible for him to start where the first man left off. Dr. Kellas has not said much this evening about his two earlier expeditions, and I gather that his achievements in the course of them were relatively slight compared with those of last year, but I venture to think he would not have achieved anything like the measure of success which he did in 1911 if it had not been for those two earlier trips. Everybody has to acquire his own experience for himself, and if any one light-heartedly imagines that he can follow Dr. Kellas and go out without any Himalayan training and accomplish anything like the same amount that he did, he will be very grievously disappointed.

Mr. FRESHFIELD: I think I may now terminate the proceedings by echoing, as I am sure all here will wish to echo, the sentiments that have been well expressed by Mr. Claude White and my friend Mr. Mumm with regard to Dr. Kellas's remarkable mountaineering tour—one of the most remarkable and probably one of the most fruitful that has ever been accomplished by a mountaineer in the Himalaya. We all congratulate him on the success which met him in his persistent explorations. We thank him for the excellent photographs he has shown us to-night, and we wish him many happy returns to the Himalaya. I am sure you will desire to carry by acclamation a vote of thanks to Dr. Kellas.

THE FLUCTUATING CLIMATE OF NORTH AMERICA.

By ELLSWORTH HUNTINGTON.

Part I.—The Ruins of the Hohokam.

Readers who are familiar with recent discussions of changes of climate are likely to say that the title of this article is exactly what they would expect from an author whose name is identified with the pulsatory theory of climatic changes. During the Pumpelly Expedition sent out by the Carnegie Institution in 1903–4 to Transcaspia and adjacent regions the present author came to the conclusion that in the dry regions of Central Asia the climate of the past was distinctly moister than that of the present. During the next two years an expedition by way of India to Chinese Turkestan, in company with Mr. R. L. Barrett, led him to extend this conclusion over a wider area and to believe that the change of climate has not progressed regularly, but by pulsations. Still another expedition to Palestine, Asia Minor and Greece in 1909 on behalf of Yale University seemed to confirm the pulsatory theory, and to show that the general course of history for at least three thousand years has been in close harmony with the supposed climatic pulsations. Moreover, the observations of others, even of men such as Beadnell, who do not believe that the climate of the Earth has changed in recent times, seem to indicate that North Africa, on the one hand, and Central Europe on the other, as well as Southern Europe and large parts of Asia, have also been subject to climatic changes. Thus there seems good ground for the conclusion that during historic times essentially synchronous climatic pulsations have taken place in all of the vast region of the temperate zone from China on the east, across Asia and Europe, to the Atlantic on the west. Obviously, if such pronounced and widespread changes have occurred in the eastern hemisphere, there is a possibility that changes of a similar nature may have taken place in America. Accordingly when Dr. D. T. MacDougal, Director of the Botanical Department of the Carnegie Institution of Washington, invited the author to co-operate with the Desert Laboratory at Tucson, Arizona, in a climatic study of the arid south-western portion of North America, the opportunity seemed too good to be neglected. Three seasons, consisting of three months in the spring of 1910, four months in 1911, and four in 1912, have now been spent in the field. The time was divided between the states of New Mexico, Arizona, and California in the United States, and Sonora, Mexico City, Oaxaca, and Yucatan in Mexico. Most of the methods of investigation were similar to those which the writer has employed in Asia, and led to a similar result. To these, however, were added some significant observations upon the relation of tropical jungle and tropical forest to civilization in Yucatan, and a series of highly conclusive measurements of trees. Both of these lines of observation, to a remarkable degree, confirm previous conclusions. The data concerning Yucatan and other parts of southern Mexico are to

be published shortly in the *Bulletin* of the American Geographical Society. The final results of the measurement of trees in 1912 are not yet ready for publication. These, together with a full account of all the results of the three years' work, and a discussion of the bearing of climatic changes on historical and geological theories, will soon be published in book form by the Carnegie Institution under the title of 'The Climatic Factor in the Evolution of Arid America.' Meanwhile the following pages contain a *résumé* of the chief conclusions derived from the observations of the years 1910 and 1911.

Investigations of the climate of the past may be divided into two distinct portions dealing with the effect of climatic variations, first, upon the form of the Earth's surface, and, second, upon the animate world, consisting of plants, animals, and men. I shall pass over the first portion briefly, leaving the fuller discussion for the report to be published by the Carnegie Institution. In arid, non-glaciated regions, the effect of climatic variations upon the Earth's surface is visible chiefly in four ways, namely, changes in the depth and quality of the soil, the formation of fluviatile terraces, the expansion or contraction of lakes, and the formation or obliteration of sand dunes. When conditions become dry there is a marked tendency toward denudation of the soil from the steeper slopes and its accumulation in deep deposits in the valleys and on the plains at the base of the mountains. On the return of moister conditions the relatively greater rapidity of weathering causes rapid production of soil, and the increase of vegetation holds this soil in place on the slopes to a far greater degree than before. Hence the streams are not only more steady and flow in full volume to a greater distance than formerly, but carry a less heavy load of waste. Therefore they become agents of erosion rather than deposition. In this way, given the proper conditions of topography, each climatic pulsation produces a terrace. Such terraces are found in large numbers in the arid south-western section of the United States, for example, along the upper course of the Gila and its tributaries in Southern Arizona. They are found almost invariably wherever the mountains are of sufficient height and steepness. Non-climatic conditions, such as movements of the Earth's crust, may, to be sure, produce similar results. Nevertheless, after due allowance has been made for other causes, the majority of the numerous fluviatile terraces which are found in such large numbers among the mountains of the American south-west seem to be the product of variations of climate. Their distribution, number, and nature are almost identical with those of similar regions in Asia, which in itself points to a common origin. The oldest may possibly go back to the last epoch of the glacial period, but there are three or four of much later date, and the youngest can scarcely be more than one or two thousand years old.

Numerous old strands of enclosed salt-lakes agree with the fluviatile terraces in indicating the prevalence of comparatively moist climatic

conditions at a time long after the last glacial epoch. For instance, in the Otero basin of Southern New Mexico certain strands are found elevated only a score of feet above the present level of the floor of a large playa, while others lie five to ten times as high. The lower strands show so little weathering compared with the upper ones that they cannot be more than a fraction as old. The upper ones probably date from the last glacial epoch, let us say thirty thousand years ago. The younger can scarcely be more than a tenth as old and may be still younger.

In this same Otero basin a third type of evidence of pulsatory changes is found in a series of gypsum dunes of several ages agreeing apparently with the strands and terraces. During arid epochs the dunes have spread from the dry floor of the playa under the influence of strong south-west winds. In moist times they have become fixed by vegetation, only to be covered once more with fresh sand on the recurrence of aridity. The agreement of these three lines of evidence—terraces, strands, and dunes—with one another, and still more with similar phenomena in Asia, is in itself sufficient to raise a strong presumption that changes of climate in America have coincided with those of Asia during the last few thousand years.

Turning now to the evidence to be derived from living beings, we may dismiss animals entirely, because their movements have not yet been investigated in respect to the problem before us. Plants will be left for later consideration, and we will take up man and his works. The south-western part of America is full of vestiges of pre-Columbian man. Some, such as the cliff-dwellings and the great irrigation works and villages of the Gila valley in Southern Arizona, are famous. A far larger number, however, are practically unknown, and have received almost no attention even from archæologists. The reason is obvious. In most cases the ruins are so insignificant that an unobservant traveller might ride miles through what was once a region thickly studded with villages without being aware of the fact. Walls for defensive purposes upon the mountains or pictographs upon the face of the rocks are apt to attract attention, but few people notice the far more important sites of villages scattered in profusion over thousands of square miles, especially in Southern Arizona, New Mexico, and the neighbouring parts of Sonora. The sites are now reduced to barren expanses strewn with ornamented bits of pottery, flint knives and arrow-heads, stone hammers and axes, mani and metate stones for grinding seeds, and in some cases rectangular lines of boulders placed erect at intervals of a foot or two and evidently outlining the walls of ancient houses. Here and there a little mound a foot or two high shows where an ancient dwelling was located. In almost every village an oval hollow surrounded by a low wall covers an area 100 or 200 feet long by half as wide —not a reservoir, as one at first supposes, but probably a ceremonial chamber of some sort. Aside from these scanty traces nothing remains. Yet there can be no question that these were once ancient villages.

Frequently the ground is full of bits of pottery to a depth of 2 feet or more, while the surface is so strewn with similar bits that one cannot walk without treading on them. The houses were probably built for the most part of branches wattled with mud. Such houses disappear quickly when abandoned, for the wood decays, and the clay used for wattling blows away, or else is spread over the ground in such a way as not to be noticeable. The more well-to-do members of the community apparently had more pretentious houses, the remains of which are probably to be found in the larger heaps of clay and rubble which occur in most villages. Close to the mountains, or in regions where stone was available, other methods of construction prevailed. There we find every type of architecture, from houses which used stone only in a single course in the bottom of the walls, to structures made entirely of roughly squared stone blocks. Some of these stone structures were cliff dwellings of three stories in front of caves, while others were isolated buildings standing in the middle of a plain and still rising three or four stories even after the lapse of one or two thousand years.

The majority of the villages must have been inhabited for a long time. Even where the houses have entirely disappeared, the amount of broken pottery covering the ground indicates that a busy population lived here for centuries. In certain cases, to be sure, the quantity of pottery is so small as to indicate only a brief occupancy. In the larger villages, however, the amount is literally scores of times as great as in certain modern villages which I examined. For example, Cababi and Juwak, near the southern border of Arizona, are villages which have been occupied by the Papago Indians for at least fifty years. So slow are these people to adopt modern methods that they still use pottery to practically the same extent as before the coming of the White Man. The amount of broken pottery in such villages is insignificant, while that in the ruins is as great as in many Asiatic ruins which are well known to have been occupied hundreds of years. I emphasize this point because American archæologists and ethnologists have laboured under a peculiar impression which amounts almost to an hallucination. Being convinced that no change of climate has occurred, they have been forced to the peculiar theory that the ancient people of America, the "Hohokam" or "Perished ones," as the modern Pimas called them, were of a different nature from the rest of mankind. It has been supposed that these ancient Hohokam were extraordinarily mobile and extraordinarily industrious. For instance, in the thirteenth annual report of the "Bureau of Ethnology" (p. 259), Mindeleff, one of the best authorities, say that "a band of five hundred village-building Indians might leave the ruins of fifty villages in the course of a single century." He assumes a degree of mobility absolutely unparalleled among any modern agricultural people, or among any of whom we have historic records. His assumption also carries with it the corollary that the Hohokam must have spent most of their time building houses or in making pottery with which

to strew the ground and give an appearance of age to their villages. Hunting tribes are of course mobile in the highest degree, but the people with whom we are dealing were strictly agricultural, as is universally agreed. The ruins of their villages are invariably located close to agricultural land, or at least to land which would be available for agriculture if there were water enough; their number, even according to those who hold the migratory theory, was too great to allow of their obtaining a living by hunting; they had no domestic animals on which to rely; and finally, traces of corn and beans, the two staple products, are found in almost every ruin. Accordingly, in the following discussion we shall follow the archæologists in assuming that the ancient Hohokam were an agricultural people. We shall depart from them, however, in assuming that, in the absence of any evidence to the contrary, the Hohokam were like the rest of mankind, and their ruins are to be interpreted by the same criteria as those universally employed in the study of the archæology of other parts of the world.

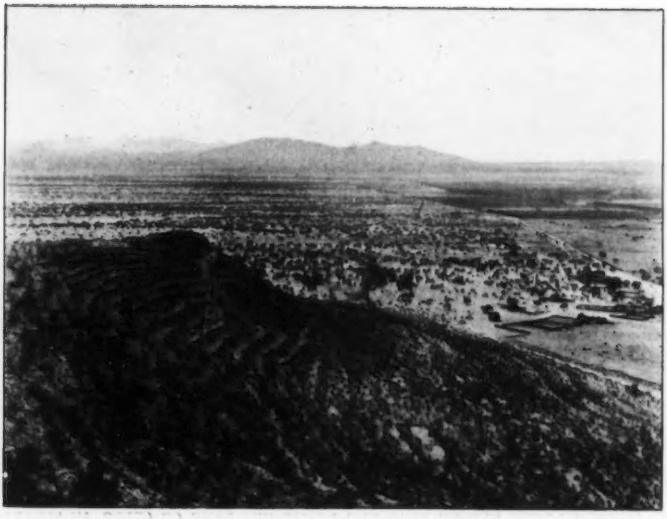
With these assumptions in mind, we are prepared to investigate the relation of the ancient population to rainfall. Let us first concentrate our attention upon a single region, the Santa Cruz valley of Southern Arizona. I select this valley, not because it is particularly remarkable, but because it happens to contain Tucson, the site of the Desert Laboratory. This town is the largest in the two states of New Mexico and Arizona, although it has only sixteen thousand people, including all its suburbs.

The reason for the scantiness of population is found in the climate. The average rainfall at Tucson amounts to about 12 inches. This is distributed between two rainy seasons; one of them comes in the winter from November to March, and has an average of about 5 inches of rain, while the other, with 7 inches of rain, begins at the end of June and lasts until early in September. The months of April, May and June, or the foresummer, as MacDougal has called them, are practically rainless and very hot, and the same is true of the interval from the end of the summer rains to the beginning of those of winter. Nothing can be raised without irrigation of some sort. Since the coming of the White Man, winter crops, such as barley, alfalfa, and the like, have become important. The Indians, however, cultivated practically nothing except corn and beans, which they irrigated by means of the summer floods.

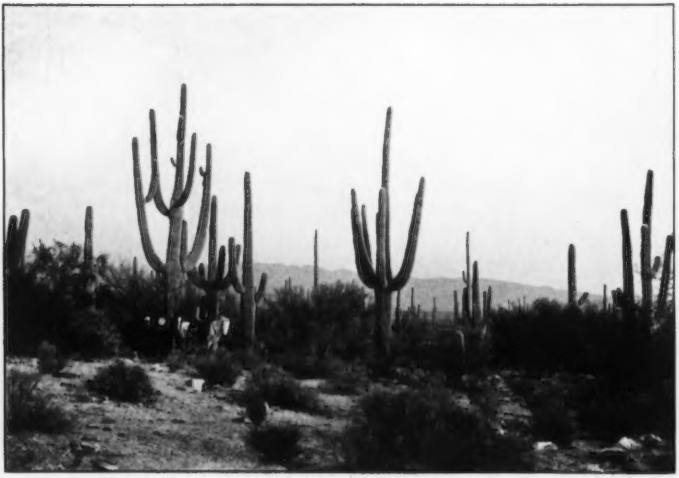
The Santa Cruz valley has a length of at least 200 miles, but most of it is well-nigh a desert, and can be utilized only for cattle-raising. According to Prof. R. H. Forbes, Director of the Arizona Experiment Station, the entire drainage area of the Santa Cruz river contains only about 6000 acres of land under cultivation. Part of the 6000 acres is under full irrigation and produces four or five crops of alfalfa per year, while a considerable portion is only under flood irrigation and produces but one crop each year, when the heavy rains of July and August redeem the desert for a brief space. Under the best system of irrigation available

DUNES OF PURE GYPSUM NEAR THE DESICCATED LAKE OF OTERO, IN SOUTHERN NEW MEXICO.

THE SITE OF A WATERLESS RUIN IN THE SANTA CRUZ BASIN AT RINCON. THE ROWS OF STONES IN THE FOREGROUND AND EXTENDING TO THE LEFT FROM THE MEXICAN ARE PARTS OF THE FOUNDATIONS OF ANCIENT HOUSES.



TERRACES APPARENTLY FOR CULTIVATION ON A DRY HILLSIDE AT TRINCHERAS. THE PROMINENT RECTANGLE IN THE CENTRE APPEARS TO HAVE BEEN THE SIDE OF A RELIGIOUS STRUCTURE.



TYPICAL FOREST OF SUHUARO OR GIANT CACTUS IN THE SANTA CRUZ VALLEY.

in modern times Prof. Forbes estimates that for every two acres brought under full cultivation one person is added to the population of Arizona. In other words, if the Santa Cruz valley were cut off from all the rest of the world and left to its own resources without railways, mines, health-seekers or other extraneous sources of wealth, the population would be limited to the three thousand who could be supported on the 6000 acres of irrigated or partly irrigated land. To this number nothing could be added by dry farming without irrigation; for Prof. Forbes expressly states that at the present time, in spite of various attempts, no such thing as genuine dry farming exists in the state of Arizona. Promising experiments give hope of some success in the future, but they involve repeated and expensive ploughing of the soil after each short period of rain, and this must be kept up for two years before any crop can be harvested. It may safely be assumed that the ancient Hohokam, with no iron tools, no beasts of burden, and no great knowledge of science, could scarcely cultivate as much land as the modern American. Moreover, as they had no winter crops, they could scarcely have raised as much food per acre as is now possible, even had they not been otherwise handicapped. For the sake of argument, however, let us suppose that with the aid of wild fruits and seeds in bad years, and with their lower standards of living, the Hohokam, if they were here to-day under the present conditions of climate, might support themselves to a maximum number of four or five thousand.

Granting that four or five thousand Hohokam might possibly find a living in the Santa Cruz valley under present climatic conditions, let us see where they would be located. Inasmuch as the ancient people were agricultural, they must have lived where both land and water were available. At present about 1500 of the 6000 arable acres are at the Indian reservation and old Spanish mission of San Xavier, 9 miles up the Santa Cruz to the south of Tucson. Six or seven hundred Indians now live there, cultivating the land, raising cattle, and going out to the neighbouring city to work. In the days of the Hohokam a somewhat dense population lived at San Xavier, as is proved by various ruins, including a fort on a hilltop. Around Tucson itself the modern houses and streets make it impossible to determine exactly how large an area was occupied by the Hohokam. In all the outskirts of the town, however, pottery and other evidences of early man are abundant, and there is a fort on Tumamoc hill where the Desert Laboratory is now located. Evidently many Hohokam lived near Tucson and cultivated the 2000 acres which can there be irrigated. A third large area of modern cultivation is found along the Rillito, a stream from the south-east which joins the northward flowing Santa Cruz, 8 miles north of Tucson. Here nearly 2000 acres are now in use. In the past the Hohokam evidently made use of the same land, for traces of villages are found near Agua Caliente, Tanke Verde, Fort Lowell, and elsewhere. The three areas of San Xavier, Tucson, and the Rillito valley include about 5500 out of the 6000 acres available for

cultivation; while the remaining 500 are scattered here and there in insignificant patches.

I have described the present distribution of population in the Santa Cruz valley, and its relation to ruins, in order to bring out the fact that the prehistoric inhabitants utilized every site which their modern successors can utilize. They did more than this, however, for in the now almost uninhabited and waterless 50 miles below the main irrigated areas of Tucson they occupied at least seven distinct villages, and others will probably be discovered. The first village, at Jaynes station on the Southern Pacific railroad, 7 miles below Tucson, must have been a genuine town. Broken bits of pottery, old grinding stones, pestles, stone hammers, flint arrowheads, and the low mounds of old houses extend for over a mile along a slight ridge of gravel between two areas of low-lying fertile land easy to irrigate and cultivate if the river contained water. Now, however, the river does not flow so far except in floods. It might possibly reach this point permanently if no water were taken out upstream, but this is not certain, and we have already seen that in former times there were numerous villages farther upstream which must have used up a large amount of water. The abundant traces of human occupation in the Jaynes village appear to indicate that the houses were close together, and were occupied hundreds of years. This one village can scarcely have had less than one or two thousand inhabitants. Adjoining it on the east we traced what seemed to be the line of a canal for more than a mile on the gravelly ground between the bottom lands of the Santa Cruz and the Rillito. Here we found not only numerous remnants of houses, but several of the hollows described above which seem to be ceremonial chambers, and which by their size and number point to a somewhat large population.

Two miles downstream from the Jaynes ruins, at the Nine-mile Water-hole, where the last permanent spring is now found in the dry river-bed, another village was located, not so large as its neighbour, but nearly half a mile long. On the opposite or north side of the Rillito we found traces not exactly of a village, but of a series of houses scattered along the edge of the arable land at intervals of a few hundred feet. If all these ruined sites were occupied at one time, which was probably the case, as we shall see later, the population of this one small region from 7 to 10 miles below Tucson can scarcely have been less than two or three thousand. That the inhabitants cultivated the low land on all sides of them can hardly be doubted; for the houses are located just on the edges of the good land, but without encroaching upon it except where the arable tracts are so extensive that an elevated, gravelly site cannot be found within a reasonable distance. The villages in the situations thus far mentioned might at present succeed in getting drinking-water without much difficulty. They could scarcely get a living from agriculture, however—and certainly not from any other source—unless the upper villages were unoccupied and all the water normally used by them were brought many miles downstream

in canals. This is scarcely possible, for the universal tendency in all irrigated regions is to use the water as far upstream as can be done profitably under the existing state of skill in the science of irrigation. In the good years, to be sure, the people of these villages might raise crops, but in the dry years they would starve.

Farther down the Santa Cruz river, by which I mean the dry bed wherein a little water occasionally flows, a small ruin lies at the mouth of the Canada del Oro, or Little Canyon of Gold. A little farther downstream, at the so-called Point of the Mountains, 17 miles north-west of Tucson, there is another large ruin known as Charco Yuma. In the spring of 1910 we found that the nearest source whence people like the Hohokam, who could not dig deep wells, could have obtained water was 8 miles upstream at the Nine-mile Water-hole. There the amount was sufficient for drinking purposes, but not for irrigation. Ranchers engaged in raising cattle informed us that no water whatever had come down the river during the preceding winter, although during the summer of 1909, when the rainfall for the hot season amounted to exactly the average amount of 7 inches, floods came down after fifteen or twenty showers. In some cases the flow of water lasted only two hours; in the height of the rainy season, however, that is at the end of July and beginning of August, a brook of more or less size flowed steadily for two weeks. The average duration of the floods was said to be about thirty-six hours. From this we infer that during a summer of average rainfall, surface water flows as far as the old village of Charco Yuma for twenty-five or thirty days during July and August. This conclusion is confirmed by the statements of Socoro Ruelas, a Mexican cattle rancher, who in boyhood and early manhood lived at the old stage station located in the midst of the ruins. In winter, according to his statement, water rarely reaches the place, and even the heavy showers of summer sometimes fail to send it so far. When he was a boy in the late seventies or early eighties the spring at the Nine-mile Water-hole increased so much as to send out a stream that was used for irrigation for a year or two. But at other times it completely dried up, so that there was no surface water within about 12 miles of Charco Yuma. From the spring of 1885 to August, 1887, according to the dates given by the Mexican, no water whatever, either in summer or winter, came down as far as the ruins, and people like the Hohokam who depend upon summer floods would have had no crop whatever in 1885 and 1886, and only a poor one when the late rains of 1887 arrived. A Mexican family could live there because, having dug a well in 1884, they had found water at a depth of 28 feet. During the following dry years the level fell several feet lower, but never absolutely failed. As the Mexicans depended on cattle and not on agriculture, the absence of surface water did not absolutely prevent them from making a living, although the scarcity of forage caused them much distress.

In spite of what has just been said, there is a little cultivation on the opposite side of the Santa Cruz valley, a mile north of the ruins of Charco

Yuma. Here, near the villageless station of Rillito on the Southern Pacific railroad, a narrow strip of land containing some 300 acres and extending along the railroad for about 3 miles is cultivated by the stationmaster and a neighbouring cattle rancher. "Talk about dry farming," said the stationmaster, "it's the easiest sort of thing. Five inches of rain a year is all we need here, and we get on an average twelve. Just look at my fields. They're not so good as usual, but they show what can be done in a bad year like this. It's all in the way you plough and harrow and roll." A little investigation, however, sufficed to show that the 300 acres are supplied with very effective irrigation, not artificial but natural. At this point mountainous spurs cause the broad waste-filled basin of the Santa Cruz to contract to a width of only a little over a mile. The rock floor of the basin lies near the surface and acts as a concealed dam to raise the level of the ground water. Also, the floods, when they come so far, spread out here and accumulate in pools. The whole tract is therefore uncommonly moist. At the time of my visit the barley in the low places where water sometimes stands was much more flourishing than elsewhere ; while in wet years, according to the stationmaster, the standing pools prevent planting. The crop was poor when I saw it because, although the rainfall of the winter of 1909-10 was only a little less than the average, it was badly distributed, most of it falling early in the winter. The grain planted in September and October and even in early November grew fairly well, while that planted later failed to head. Even in the best part of the 300 acres, however, that is in the most moist depressions, the hay crop, for which the barley is planted, was expected to amount to only about 15 tons as compared with 95 in the preceding year.

What sort of a crop would be harvested in a really bad year no one knows, for cultivation has only been carried on a few seasons. At least a quarter and probably a third of the winters during the last forty years, since records of precipitation began to be kept in the region, have been even more unpropitious than 1909–10. If a poorly distributed but not especially small rainfall in that year could cause the diminution of the crops to the extent of five-sixths, it requires no demonstration to show that the fields must have been almost useless in the nine years since 1887 when the winter rainfall has been less than 2·5 inches. Outside of the 300 acres now in use many attempts at cultivation have been made near Charco Yuma, but without success. In years like 1904-5, to be sure, with nearly 15 inches of winter rain between October and April and 6 in the summer, from July to September, or like 1906-7 with nearly 8 in winter and 11 in summer, fine crops can be raised in many places, but this is the exception, not the rule.

To sum up the conditions at Charco Yuma, it appears that no permanent supply of water is available without the digging of wells at least 25 feet deep, a task impossible for a primitive people without iron tools. The nearest permanent supply of water is 8 miles away, and even that occasionally fails. A period of two years and more may pass without a single temporary

flow of water. The total amount of land capable of cultivation amounts to about 300 acres sufficient to support 150 or 200 people in ordinary years, but the yield from this land has fallen off as much as 85 per cent. in recent dry years, and must fall off more in the frequent seasons which are worse than the one in question. Winter crops such as have just been mentioned, however, had no importance for the Hohokam since they had no wheat, barley, oats or other grains of the Old World, but depended almost solely upon maize and beans which require summer rain. According to Ruelas, the Mexican, no flood waters reached Charco Yuma in 1885, when the summer rainfall amounted to only 3·07 inches, the minimum on record, nor in 1886 when it amounted to 4·27 inches. If *no* water reached the place with a rainfall of 4·27 inches we may safely infer that at least 5 inches would be required in order to raise any crop whatever. During the 42 years for which records are available, 15 summers, or more than one-third, have had a rainfall of less than 5 inches. We seem compelled to conclude that at present the total amount of land which could be cultivated under the Hohokam methods amounts to only 300 acres, which would yield no appreciable crop at least one year out of three, and poor crops about half of the rest of the time.

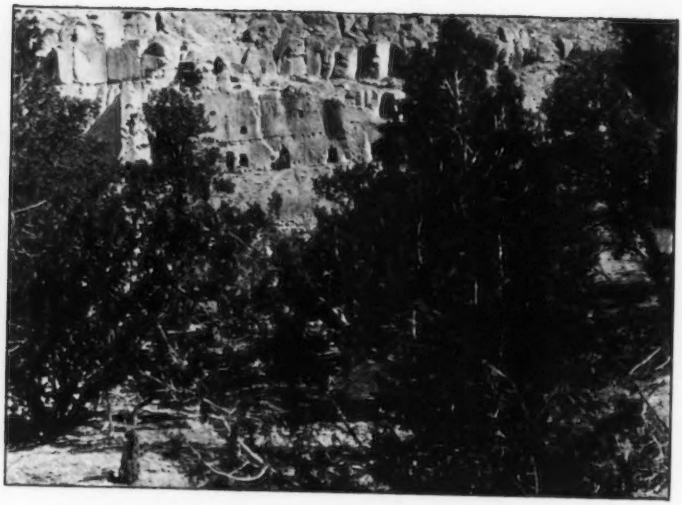
In spite of these untoward circumstances the Hohokam lived here in considerable numbers. On the left bank of the dry river-bed, between the channel and the base of the jutting point of the Tucson mountains, Mr Herbert Brown, editor of the *Tucson Star*, showed us the remains of a large village. For nearly 2 miles we found pottery and other artifacts scattered along the base of the mountains, not thick as a rule, but at frequent intervals as if houses had been located here and there along the edge of the cultivated land just as we have seen to be the case farther upstream, or as the modern houses of the Papago Indians are located at San Xavier. In the centre of the village the pottery is thicker. There we found a great boulder of andesitic lava almost buried in alluvium. It was studded with 24 round holes about 10 inches deep and 3 or 4 in diameter, while a similar block not far away contained 7 holes of the same sort. Long ago the Hohokam women must have gathered here with their stone pestles, and gossiped as they sat on the great rocks and pounded corn, beans, or other seeds to make flour for the daily bread of their husbands and sons. Not far away an elliptical enclosure of the kind which we have supposed to be a temple or place for religious ceremonials, has a length of 210 feet and a width of 90, dimensions sufficient to indicate a village of considerable size. Back of the temple and the great grinding stone, if these are the proper terms, the whole eastern and northern face of the steep rocky hills is covered with low defensive walls, enclosing spaces 10 to 30 feet wide, where families appear to have taken refuge in times of danger. At first one is inclined to say that there must be a thousand of them. We did not actually count, but a rough estimate shows that they surely number several hundred, which gives some idea of the probable size of

the village down below. In addition to the ruins already described there was still another large village in this vicinity on the farther side of the Point of the Mountains, that is half or three-quarters of a mile downstream. Here for nearly a mile and a half along the gravel terrace above the alluvial plain of the Santa Cruz, and overlooking at a distance the 300 acres now under cultivation, pottery and the usual accompanying artifacts are thickly scattered. The central part of the village occupies an area of about 200 acres, while the surrounding part where population was less dense covers a slightly larger area. In the centre of the village, pottery is very thickly strewn, and the upper layers of earth are full of it to a depth of 2 feet indicating very long occupation. This lower village was larger than the one on the other side of the mountains; and, to judge from the degree of ruin of its ceremonial chambers, it appears to have been occupied longer and abandoned earlier. Moreover, there are no defensive walls, so far as we could discover on the side of the hills facing it, although there are plenty on the other side. All these things suggest that the original village was down stream from the Point of the Mountains, and existed during a time of peace, prosperity and dense population, while the other village was occupied later, perhaps at a time when the water-supply was becoming less so that it was necessary to move upstream above the rock-dam of the mountains. At the same time more war-like conditions began to prevail, possibly because of the distress due to lack of rain; and accordingly the people of the village were obliged to build places of defence upon the mountain-side.

Below Charco Yuma agricultural conditions become less and less favourable. Nevertheless ruins of villages are found at Nelson's Desert Ranch 26 miles from Tucson, at Picacho 16 miles farther down the Santa Cruz, and in several localities south of Toltec Station which is about 55 miles north-west of Tucson. These last sites lie in a region where a recent attempt at irrigation has been made on a large scale. A dam of earth was thrown up to collect flood-water, and canals were constructed to distribute it over a plain of the richest soil. My first knowledge of the project came from the sight of a cloud of dust which I saw from a mountain-top many miles away. "That," said my companion, "is the dust of the 4000 acres that the Santa Cruz Reservoir Company ploughed up and planted with barley last fall. Not a grain of their barley has come up in the whole 4000 acres, and yet they are trying to sell farms." Later I rode through the dust of the great ploughed field—dust ankle-deep—and saw with my own eyes that there was not a vestige of any growing thing. During the winter no water came down to fill the reservoir; the next summer brought no better success, and the project was abandoned. The entire group of ancient villages in this region of unsuccessful irrigation below Charco Yuma must have contained as many people as the groups at either Jaynes or Charco Yuma. In every village of this most remote group the problem not only of raising crops, but of obtaining drinking-

CLIFF DWELLINGS IN THE CANYON DE LOS FRINOLES.

RUINS OF TUIYONI IN THE CANYON DE LOS FRINOLES.



CLIFF DWELLINGS AT THE LARGE RUINS OF PUYÉ.

PREHISTORIC CARVINGS AT PUYÉ.

water, would utterly prevent primitive people from living there under present conditions. Wells a hundred or more feet deep, such as support the few far scattered cattle ranches of modern times, were of course out of the question. Reservoirs were doubtless the common resource, but they were apparently constructed merely of earth without plaster, and at best they must have been shallow. If for ten consecutive months no floods came down the river to this point, as happened in 1909-10, all the water must have disappeared by seepage or evaporation, to say nothing of daily use, long before the supply was replenished; while periods like 1884-6, when there were no floods for at least thirty months, would inevitably cause the complete abandonment of such a village and probably the death of most of its inhabitants, by reason, not only of hunger and famine, but also of the wars and dissensions, which would inevitably arise when all the country was in the throes of terrible drought.

To sum up the conditions in the Santa Cruz valley, it appears that at present not more than four or five thousand people could find sustenance without modern railroads and other means of outside assistance. The part of the valley which is now capable of cultivation contains ruins which indicate that all the available land was utilized in the past. Below the point where irrigation is now possible there are three large groups of ruins, and the three together must have had as many people as the higher regions where there is still water. In other words, it seems as if the Santa Cruz valley once had at least twice as many people as it could at present support, and half of these lived where the white man cannot now get a living from agriculture.

Before leaving the Santa Cruz drainage area we must describe two sites located at the headwaters of tributaries and affording phenomena different from those thus far discussed. The first is at Gibbon's ranch, east of Tucson, at the southern base of the Santa Catalina mountains. This is one of the few places where the water-supply depends upon a spring rather than a stream. In 1910 we found the site unoccupied, although a decaying adobe house stands beside a small reservoir supplied by two or three trickling little springs. The total amount of water in March, 1910, would scarcely have sufficed to irrigate three or four acres, an amount so small that the owner of the ranch did not find it worth while to practise agriculture at all, but turned his attention to cattle raising. Since his death or removal, no one has lived there. Some day, perhaps, a thrifty Chinese peasant will establish there a market garden. He will certainly be most skilful if he can make the water suffice for the support of more than two or three families. Yet once there was a respectable village here. East of the dry "wash" or sandy flood channel which occasionally carries water for an hour or two while rain is falling, my guide, Mr. Bovee, and I counted the stone foundations of twenty-eight houses in an area of 8 acres, while we found pottery quite thickly strewn over 40 acres. We doubtless missed some of the houses, either because

their foundations have been concealed by the washing of gravel in floods, or because their appearance is insignificant. Hence we seem to be well within the limit if we say that the population of the village in its prime was probably as much as 120, whereas now the available water supply is sufficient for little more than one-tenth as many. I am well aware that the common objection to this conclusion is that the ancient Americans did not occupy all the houses of a village at once; that people built houses, and then if some one died they built others; and thus there might be many times as large a number of houses as there were families. This view, however, is absolutely unproved. Its basis is, first, the fact that certain modern tribes of Indians, few in number, and living largely in huts of a temporary and easily constructed character, have the habit here described; and, second, the unfounded assumption that the population of the south-west in ancient, prehistoric times cannot possibly have been so large as the ruins would seem to indicate because the country cannot now support so many people. In reply to this, it may be said, first, that we have absolutely no knowledge of the customs of the Hohokam, apart from what we learn from their ruins, nor do we even know that they were related to the modern Indians any more closely than we are supposed to be to our fellow Indo-Europeans, the Persians. In the second place, the habit of abandoning dwellings after some one has died in them is not at all common at the present time, and it rarely, or possibly never prevails among a purely sedentary, agricultural people such as the Hohokam appear to have been. It is practically limited to tribes who wander from place to place and whose habitations are consequently of the nature of booths or mere temporary shelters, easily removed and easily renewed. In the third place, the size of the central structure of each ruined village, the supposed ceremonial chamber, is sufficient to indicate a considerable number of people. The stone foundations of the structure at Gibbon's Ranch, for example, have a length of 105 feet, and it hardly seems probable that a mere handful of Hohokam, ten to twenty in number including women and children, would have built so large a building. Finally, it is in the highest degree unscientific to assume that conditions of climate have always been as they are to-day. It may be that those who hold this view are right, but they are certainly not justified in making the assumption when the matter has never yet been submitted to any rigorous mathematical investigation such as is here attempted.

After studying the ruins of the main Santa Cruz valley I came to the conclusion that a mere examination of the map was sufficient to indicate where ruins would be found. Accordingly I decided upon the head of the Rincon valley, about 22 miles south-east of Tucson, as a test case. The expected ruins were found in the shape of several small villages, the chief of which contains the foundations of at least eighteen houses. Probably there were once many other houses in the valley, for abundant pottery is found in several places where no foundations are visible. The present

population consists of two Mexican and two American families, one of the latter being the forest ranger; but the arable land is said to amount to 150 or 200 acres, which would permit of a population of twenty or twenty-five families. The significant fact in this case is not the discrepancy between the present and past population. The number of inhabitants in the past was not limited by the amount of water available in the stream, but by the amount of level land in the narrow bottom of the valley. Apparently the Hohokam wanted more land than they could readily obtain. About a mile and a half east of the forest ranger's house and some 3 miles east of the prominent hill called Sentinel Butte, a grassy slope drops towards the north-west at the base of Rincon peak, 8465 feet high. The slope has a fall of about 10 degrees, and an altitude of from 3300 to 3500 feet above sea-level. On the most favourable part of the slope, for a distance of about half a mile parallel to the upper Rincon, and for a width of half or two-thirds as much, one finds unmistakable terraces built apparently for purposes of agriculture. In general they are from 20 to 70 feet long and 2 or 3 feet high. The commonest location is at right angles to the minor drainage lines, each little swale being broken into terraces with a width of from 20 to 30 feet. In some cases the spaces between the swales are also terraced, the terrace walls in all cases being composed of pebbles and cobblestones. I searched carefully for pottery, but succeeded in finding only one or two coarse bits, quite in contrast to the abundant potsherds which occur not only among the foundations lower down the valley, but along the borders of the alluvial plain. The only other works of man among the terraces are some small stone circles like the beds where the modern Indians cook the yucca to make the drink known as mescal, and the low round structure of boulders. The whole hillside is almost exactly like hundreds in Palestine, Syria, and Asia Minor, or like others in Mexico and South America. Even the little round structure, about 7 feet in diameter, with its small doorway, resembles the watchmen's shelters in the terraced fields of Syria. There can scarcely be any doubt that the terraces were designed for agriculture. Apparently they were not intended for irrigation, for they are not properly arranged for this, nor does there appear to be any available source of water. They must have been intended for dry farming. Three or four miles down the valley, near the main village, a few similar terraces occur on a gravel slope east of the ruins and far above any available supply of water, so that here too dry farming appears to have been attempted.

Prof. Forbes, of the Arizona Experiment Station, as has already been stated, says that dry farming is not now practicable in Arizona except by most careful and expensive methods of ploughing and harrowing continued for two years in order to get a single crop. The terraced slope in the upper Rincon valley, because of its proximity to the mountains, undoubtedly receives more rain than do many parts of the country. Over on the east side of the neighbouring Santa Rita mountains at an elevation

considerably greater than that of our terraces, potatoes have been reported as grown without irrigation, but inquiry shows that they are watered naturally by springs seeping out above them. In the same region, at the mouth of Gardener's canyon at an elevation of 5000 feet, four or five settlers took up land and attempted real dry farming in 1909. The elevation is sufficient to ensure moderately cool weather, and hence less evaporation than in the parching plains. The rainfall during the summer season of 1909, as measured at the Empire Ranch not far away, amounted to 9·39 inches as against an average of 7·93 for the preceding fifteen years. Nevertheless, the corn of the settlers failed utterly; and the beans, the most reliable of all crops, gave so scanty a return that the farmers were completely discouraged. In the absence of records we cannot say categorically that crops might not be raised on the terraces at Rincon. We can merely say that nothing of the kind has succeeded in this part of Arizona hitherto, and that in April, 1910, we found the terraces with no more sign of fresh vegetation than was apparent on the surrounding dry plains.

The hypothesis may be advanced that the Hohokam prepared the terraces for the cultivation of some special crop, such as wild tobacco or some plant now unknown, for which dry conditions are especially favourable. Wild tobacco does not now grow here, however, and we know of no other plant which could have fitted the requirements. It is scarcely probable that a plant of sufficient importance to demand so large a space and so great an expenditure of effort would have escaped from cultivation and from knowledge after having once become a part of man's equipment.

Apart from the immediate question of the possible climatic significance of the terraces, they are important in another aspect. Mankind rarely labours except under the compulsion of some strong force such as hunger, fear, or ambition. The ancient Hohokam would scarcely have gone to the labour of making the terraces without some good motive. The obvious agricultural character of the terraces precludes the possibility of any religious significance, as does the fact that elsewhere such terraces are found closely associated with religious structures from which they are clearly differentiated. Defence apparently had nothing to do with the matter, for there seems to be no fortress near at hand, the terraces are in a decidedly undefensible location, and they are not protected by walls. The only adequate explanation would seem to be the need of more abundant areas of cultivation. Probably the Hohokam of the Rincon valley found that the limited amount of land in the bottom of their narrow valley was not sufficent for their needs. Therefore, having somehow learned the art of making terraces as practised in other parts of the arid south-west or in Mexico, they built a considerable number, partly close to their main village, but chiefly on a slope of especially favourable location. This in itself may seem of small importance, but it is significant as indicating that probably the population was decidedly dense. Had there been abundant

unused irrigable land either in the Rincon valley or in neighbouring regions, the Hohokam would scarcely have gone to the labour of building terraces. Hence we infer that the population of the country as a whole was as dense as is indicated by the abundant ruins.

The preceding pages have been devoted to the description of the phenomena of a single valley in southern Arizona. That valley was not chosen because of the strength of its evidences of climatic changes, but merely because it happened to be the first which I investigated and the one where I spent most time. Half a dozen others might have been chosen equally well. The same type of phenomena are displayed with equal clearness in the Altar valley of north-western Mexico, in the Chaco valley 500 miles to the north-east in the north-western corner of the states of New Mexico, and in unnumbered valleys between the two, and in the regions round about. Wherever I investigated the matter I found the same type of evidence. Further details would overcrowd this article and I must dismiss this phase of the subject with one more brief example. The Jarilla mountains are an insignificant group of detached hills lying in the centre of southern New Mexico, 50 miles north-north-east of El Paso and 300 miles east of Tucson. Because of the presence of copper and other metals a small mining industry grew up here a few years ago, but its boom is over and only a few hopeful prospectors still remain. As no water could be obtained among the mountains, the railroad had previously been forced to construct a pipe-line to some higher mountains 20 miles to the east. Except during the rainy seasons when a little water is stored in cisterns, the water piped from the east has been the sole supply, not only for the railroad itself, but for the two little mining towns so long as they had any inhabitants. So far as I could learn, only two persons, both of whom combine a little cattle-raising with the enticing but unremunerative occupation of prospecting, depend on any other water supply. These two men live far off from the rest of mankind, and get their water from deep wells, the digging of which would be utterly beyond the capacity of primitive people without iron tools. The only surface water is in Water canyon, but the name is a misnomer. The settler who lives there was most scornful when I asked about the "spring." He said there was no spring, only a damp spot in years of unusually good rainfall. My visit to the place confirmed his statement. I saw nothing but a waterless valley, slightly damp because rain had fallen the day before; but no one would ever suspect the presence of a spring except from the traces of an old path and of an Indian settlement. In spite of the present absolutely uninhabitable character of the Jarilla mountains for any people not able to dig wells, and in spite of the fact that no crops whatever can be raised there without constant irrigation, I saw the remains of three distinct villages of the kind already described. The pottery and other relics of man are not so thick as in the large villages of the Santa Cruz, but they are so abundant that the ground is thickly strewn with them. Not one of the villages is less than half an hour's walk from the dry spring, and two of

them are 4 or 5 miles away. All are obviously located close to land which could be cultivated by flood irrigation if there were enough water and if the inhabitants could have a permanent supply to drink. The case is only one of hundreds scattered all over New Mexico and Arizona. It seems inexplicable on the theory of climatic uniformity, but perfectly reasonable if the climate of the past was different from that of the present.

(*To be continued.*)

SOME RECENT OBSERVATIONS AND THEORIES ON THE STRUCTURE AND MOVEMENT OF GLACIERS OF THE ALPINE TYPE.

By ALAN G. OGILVIE.

GLACIERS are of perennial interest alike to mountaineers and to physical geographers. Every mountaineer must have asked himself why the crevasses cut the ice-mass in one general direction at one part and quite otherwise in another; what are the causes of the banded appearance and of the granular character of the ice; and how it comes that a streak of moraine starts, with no apparent cause, at some point of the surface and grows broader and thicker as it passes down to join the great shoot of gravel and boulders where the ice ends. Students of physical geography have not yet agreed as to the *rôle* played by glaciers in the development of terrestrial relief. Is the glacier an active agent of erosion, or is it not? and if it is, what is its mechanism as a tool of erosion?

On all such questions much light has been thrown by some recent observations and theories with regard to the internal structure of the ice of glaciers of the Alpine type, as well as to the details of glacier movement and its relation to the transport of moraine matter.

The chief object of the present paper is to give some account of the work of the observers who have of late made important additions to our knowledge of these matters. At the same time it will be of advantage to review briefly the general features of alpine glaciers. Indeed, the convenience of introducing thus the technical terms which have to be employed in the later part of the paper is sufficient reason for giving here a summary which must be marked by the defects that are unavoidable in a condensed statement of so large a subject.

The glacier consists of the *névé*, or collecting area, and the tongue, or area of melting or ablation. To these H. F. Reid has applied the names "reservoir" and "dissipator." The boundary where the one passes into the other is called the "*névé* line." The whole glacier lies upon an inclined bed, and in the bigger glaciers the *névé* generally occupies a wide basin while the dissipator lies in a narrow valley.

If, in any given time, the quantity of snow accumulating on the *névé* is equal to the amount of ice which passes the *névé* line, and this in turn is equal to the quantity of ice which is melted in the dissipator, the glacier is said to be in equilibrium, and, so far as its dimensions are concerned, it is "stationary." In this stationary condition of the glacier, its "front" or "snout"—the termination of the dissipator—neither advances nor retreats. In such a glacier the surface of the *névé* remains at a constant level, and each fresh addition of snow on the surface is followed by a downwards motion of the ice which has

been formed by previous accumulation. The upper surface of the fresh snow in the *névé* is melted by the sun's rays. The water sinks in for some distance, until it freezes, when it unites several snow crystals so as to form granules of ice. The snow thus becomes gradually more and more compact, till at last it is entirely changed into a translucent mass of ice.

The process which follows is not well understood, but it is certain that the grained structure—to which we must return—remains throughout the entire length of the glacier, and that the granules, of which each is a single crystal, grow until, at the glacier front, they are often as large as a hen's egg; there indeed a freshly broken surface often has an almost nodular appearance.

The *névé* shows a well-marked stratification wherever the crevasses permit sections of it to be seen. As a general rule each bed of the strata corresponds to a single snowfall, while thin bands of fine wind-borne dust, which frequently separate the layers, represent periods of dry weather. Whether the dust layer be present or not, the crystalline surfaces of each bed are more or less plane,

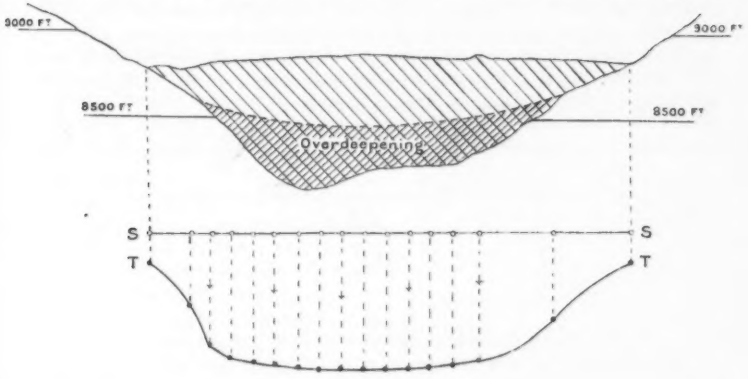


FIG. 1.
(After Hess, 'Die Gletscher.')

although inside these surfaces, and throughout the bed, the crystals are interlocked in the most irregular way.

Observations taken over many years have shown that the average rate of motion in various glaciers of the Alps lies between 100 and 500 feet per annum. In the dissipator the surface velocity is unequally distributed, the centre moving faster than the edges. This variation depends upon the breadth, the depth, and the shape of the cross-section, as well as upon the slope of the glacier bed. This is well illustrated in Fig. 1. The curved line TT represents the deformation produced upon a line of stones which was originally a straight line, SS, across the glacier. It will be noticed that the critical points of the curve are exactly above the ledges of the "overdeepened" part of the valley. This proves that the surface velocity is greater where the ice is deeper.

The deformation of the surface ice, like that of the line of stones, is greatest between the critical points and the edges of the glacier. By taking the average of all observations of this sort, Hess found that the proportion of maximum to minimum velocities in one line of stones was as 100 to 78.

In the dissipator, towards the glacier front, there is a striking decrease of

velocity even when the slope of the glacier bed is not diminished there. This, according to S. Finsterwalder, is due to the decrease in the thickness of the ice in this part which is produced by ablation.

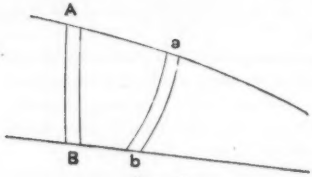


FIG. 2.

The velocity decreases from the surface of the ice towards the rock bed, the lower portion being retarded by friction. Thus there exists not only a horizontal deformation (see Fig. 1), but also a vertical deformation. In Fig. 2, which represents a longitudinal section in the glacier tongue, a column of ice, AB, undergoes deformation while moving to the position *a b*.

The Crevasses.—Considerable light is thrown upon the physical properties and upon the structure of the ice by the crevasses. The lack of elasticity which produces them shows that glacier ice cannot be satisfactorily compared to a flowing liquid.

The maximum horizontal deformation in the tongue, as we have seen, takes place near the edges. The ice here undergoes a tension produced in the direction indicated by the deformed lines of stones. When this tension exceeds a certain limit, the ice gives way and "lateral crevasses" are formed, which have a direction perpendicular to the tension (see Fig. 3). Except at the extreme

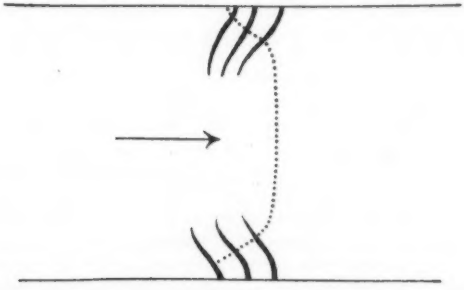


FIG. 3.

edges, these crevasses rarely extend farther into the body of the ice than one-third of the depth of the glacier, and it is considered possible that below this point the ice is more elastic.

As the glacier passes over a step, or rapid fall, in the bed, the ice-mass becomes bent so that the surface is convex, and a longitudinal tension is produced. Enormous "transverse" crevasses open, often extending right across the glacier (see Fig. 4). Below the step the surface becomes concave, the crevasses close up by regelation—though their marks remain—while it is possible that transverse "ground" crevasses open on the under surface of the ice. If the step is very steep, the transverse crevasses formed at its upper part may reach right through to the bed, so that great slices of ice are broken off and slide slowly down vertically to the lower level.

Where the glacier widens, as it often does at its foot, the lateral compression is relaxed, and the spreading of the ice causes a tension outwards from the

centre line to the sides of the glacier. As a consequence, "longitudinal" crevasses are formed wherever the glacier broadens.

In the *névé*, irregular crevasses are produced by changes in slope which are very frequent in this region. These crevasses are generally narrow at the surface, widening downwards and then gradually narrowing in their lowest parts.

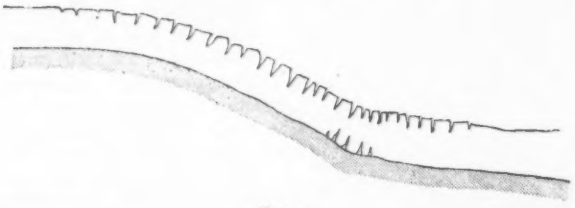


FIG. 4.

Hans Crammer has explained this phenomenon by attributing its formation to a series of snow bridges which have formed, year after year, over a widening crevasse, and which have themselves been broken each year by tension.

In Fig. 5 the thick line represents the *névé* surface when the crevasse began to open: *a*, *b*, *c*, *d*, *e*, represent the beds which have formed snow bridges in successive years.

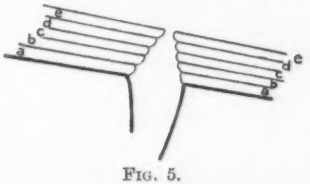


FIG. 5.

Round the upper side of the reservoir, and roughly parallel to it, there runs a long irregular crevasse—a natural moat for which no specific term exists in English—the "Bergschrund" or "Rimaye." The snow or ice slope above this crevasse and nearer to the walls of the "cirque," is always much steeper than the *névé* surface below it. The Bergschrund, in fact, marks the line where the real downward motion of the *névé* begins; the frozen matter above adheres to the walls of the cirque.

The Line of Flow in the Glacier.—The idea of a flowing motion of the glacier is far from new, having been suggested in 1773 by Bordier, and associated later with the names of Forbes, Tyndall, and others. In recent years it has been much developed and elaborated independently by S. Finsterwalder and H. F. Reid. The theory * may be briefly stated as follows:—

The ice is regarded as an incompressible mass. Each particle of snow which falls upon the *névé*, after being converted into ice, begins to follow a definite course in the interior of the glacier. It eventually emerges at a definite point on the surface of the dissipator.

Thus all the points of entrance in the reservoir may be joined to corresponding points of exit in the dissipator by lines of flow in the interior. A horizontal projection of these lines is given in Fig. 6, while Fig. 7 shows a longitudinal section, exaggerated vertically, both the lines of flow and the planes of stratification being indicated. It will be noticed that those lines of flow which begin at the margin of the *névé* run along the base of the glacier and emerge at the margin of the tongue; those which start from other points on the surface of the

* A model constructed, under the direction of the author of this paper, to illustrate this theory has been placed in the Science Museum, South Kensington.

reservoir pass inwards there at definite angles, and terminate by reaching corresponding points in the surface of the dissipator. In the *névé* the strata have more gentle slopes than the flow lines, while in the tongue the reverse is the case.

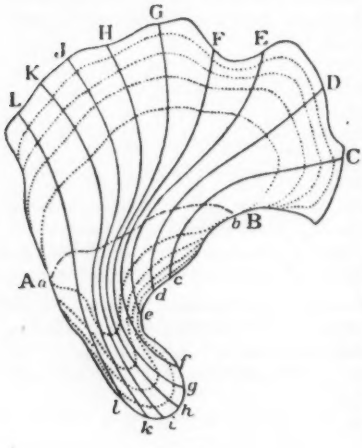


FIG. 6.

A*a* — · — · — · — · — *b*B = *Névé* line.
as H*h* = Lines of flow.
..... = Lines dividing the glacier into areas of equal accumulation and ablation.

(After Finsterwalder, 'Zeitschrift des D.U.Ö. Alpenvereins Wissenschaftliche Erganzungshefte,' vol. 1, No. 1.)

The Structure of the Ice.—Wherever the glacier enters a narrow valley it is subjected to immense lateral pressure. This fact coupled with the kind of movement just mentioned is sufficient, according to Hess, to explain the gradual transition of the strata from their almost horizontal position in the *névé* into a spoon-shaped form in the tongue. Hess believes that such a form is indicated by the observations which can be made at the surface, and in illustration of the changes of form which he describes he has carried out most interesting experiments in which he squeezed stratified wax out of a narrow opening in a cylindrical reservoir.

This leads us to the consideration of the observations made many years ago upon the structure of the glacier tongue — ("veined structure," "structure rubanée," "Bänderung," "Blätterung"). In the upper part of the dissipator, the ice appears to be striped, in a longitudinal direction, with alternate bluish and white bands or veins. The difference of colour is due to a greater amount of air being imprisoned in some bands—the white—than in others—the blue.

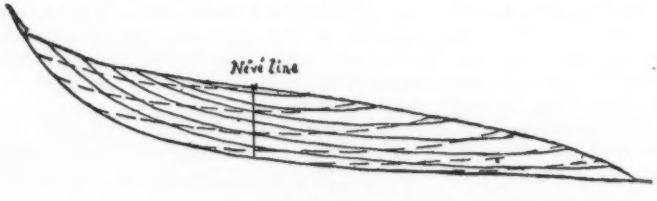


FIG. 7.

– – – – – = Stratification lines.
——— Lines of flow.
(After H. F. Reid, 'Appalachia,' vol. 11, 1905-08.)

In lateral and transverse crevasses these veins may be traced into the interior of the ice, and it is easy to observe that at the edges of the dissipator they dip roughly parallel to the bed of the glacier, while towards the centre they become more and more vertical. In the lower part of the tongue the veins cease to crop out in this manner and commence to cut the surface in great arcs pointing down-stream.

This observation led Agassiz to construct sections of simple and composite glaciers to show the forms produced by the lateral pressure (see Fig. 8). These forms are very similar to those which resulted from the wax experiments of Hess.

The view of Agassiz that the veined structure is simply the stratification transformed, has been accepted by most glaciologists, but it should be noted that Prof. Forel is among those who do not accept it.

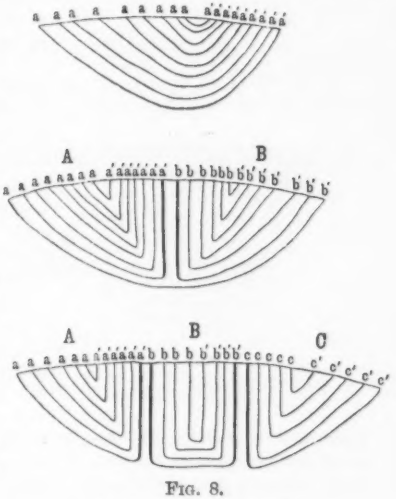


FIG. 8.

Agassiz, "Système Glaciaire."

Recent Observations on the Veined Structure. — Much supplementary data has been collected with reference to the manner of this transition. On the glaciers of Forno, near the Maloja, and Unteraar, in the Bernese Oberland, H. F. Reid followed the veined structure up-stream until its identity with the stratification was undoubted; and the Glacier Congress of 1905 emphatically expressed the opinion that the veined structure has its origin in the stratification.

A most interesting series of observations made by Hans Crammer on the glaciers of the Eastern Alps, and especially on the Marzellferner and the Obersulzbach glacier, have led him to the same conclusion, Since Crammer has based an important theory upon his observations, it will be useful to follow his account of the phenomena which he saw under particularly favourable circumstances; for it so happens that in the glaciers upon which he worked, and especially in that of the Obersulzbach, great transverse crevasses permit the structure to be examined exactly at the point where the wide reservoir narrows to form the root of the tongue.

Some distance above this point, the *névé* strata were observed in the crevasses to have an undulating form, the axes of the undulations running in the direction of flow. A little farther down-stream these undulations were seen to have become well-marked folds. Moreover, ablation—which removes more and more of the surface ice as the glacier passes down the valley—was at work here; thus the surface of the glacier cut the anticlines and synclines of the folds so that their outcrops formed great arcs pointing up-stream and down-stream respectively. Still farther down-stream the folds become sharper and the arcs of outcrop more elongated. Folds similar to these were recognized in the Rhone glacier by the Glacier Congress of 1899, and a series of long ridges and furrows on the surface—the effect of ablation upon the folds—were given the name "Reid ridges." Finally, the two limbs of each fold, as well as those of the surface arcs after being squeezed closer and closer together, were observed to coincide, and to produce a single vein or band. These bands as seen on the crevasse walls were vertical in the centre of the glacier and more inclined near the edge. The appearance of their outcrop on the glacier surface was exactly that of the veins already recognized as running parallel to the direction of flow

A close examination of the veins showed that they were not continuous bands, but were composed of a great number of lenticular "leaves" ("Blätter" of Crammer) which overlap, the one on the other (Fig. 9).

FIG. 9.

These observations on the origin of the veined structure led Crammer to the conclusion that their disposition in the interior of the tongue is not such as is shown in Fig. 8, but that they have in reality the form of a fan (Fig. 10).

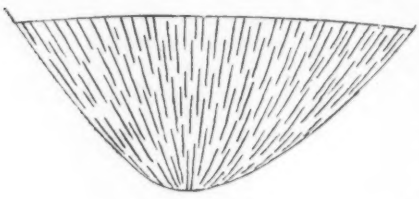


FIG. 10.

(After H. Crammer, 'Mitteilungen der Geographischen Gesellschaft,' Munich, vol. 4. 1909.)

In the glacier foot of the Marzellferner, which had retreated recently within a narrow valley, Crammer was able to see a section of this sort. But this is an exceptional case, and in most glaciers the veined structure appears in the foot in a spoon-shaped form. Such glaciers, according to Crammer, have room to spread at their foot, and are either stationary or advancing; only in a retreating glacier, such as the Marzellferner, where a part which has not spread has become the front, does the veined structure there show in a fan-shaped form. The spoon form of the veined structure, as seen in plan, is shown in Fig. 11, and its longitudinal section, which can be seen in the terminal longitudinal crevasses, in Fig. 12.

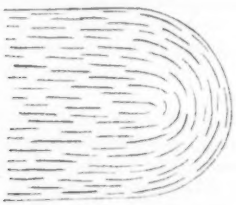


FIG. 11.

FIG. 12.

(After H. Crammer, 'Mitteilungen der Geographischen Gesellschaft,' Munich, vol. 4. 1909.)

This explanation of the veined structure may be applied to sections of a composite glacier: Fig. 13 for comparison with Fig. 8.

The explanation given by Crammer of the change produced upon the structure, in glaciers which have a wide reservoir and a narrow dissipator, is as follows:—

The rock bed of the reservoir is basin-shaped, and narrows down-stream. Thus a bed of *névé*, flat when it is formed by snowfall, comes to occupy a less extensive area as it gets overlaid and sinks, and as it passes from the broad upper basin to the narrowing part, towards the *névé* line. The bed of *névé* is compressed from side to side by lateral pressure, which reduces its area by

throwing it into folds with their axes at right angles to the pressure, *i.e.* in the direction of flow. The greatest amount of folding takes place at the base of the mass and where the narrowing of the bed is most marked, generally about the *névé* line.

This theory is clearly illustrated in Figs. 14 and 15. Fig. 14 shows a glacier divided so as to show successive cross-sections: Fig. 15 is a cross-section cut at the *névé* line.

One of the arguments which have been brought against the theory that the veined structure has its origin in the stratification, is that bands lying nearly horizontal have been seen in crevasse walls to cut the vertical veining, and that the two types represent the stratification and the veining present together.

Reid has declared these horizontal bands to be reclosed crevasses, and Crammer gives a similar explanation, thus:—

When the glacier passes over a steep step in the valley the transverse crevasses which opened on the convex surface of the ice become vertical planes of shearing which reach to the bottom. Immediately below the step, these shear planes or their scars are vertical, and crop out in straight transverse lines. Differences of velocity, however, soon cause them to undergo a

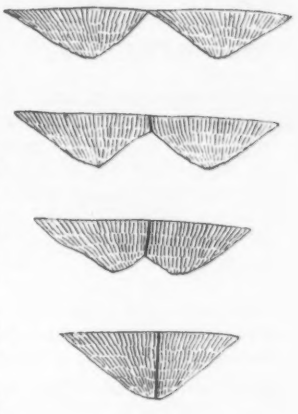


FIG. 13.

(After H. Crammer, 'Neues Jahrbuch für Mineralogie,' etc., vol. 18, 1904.)

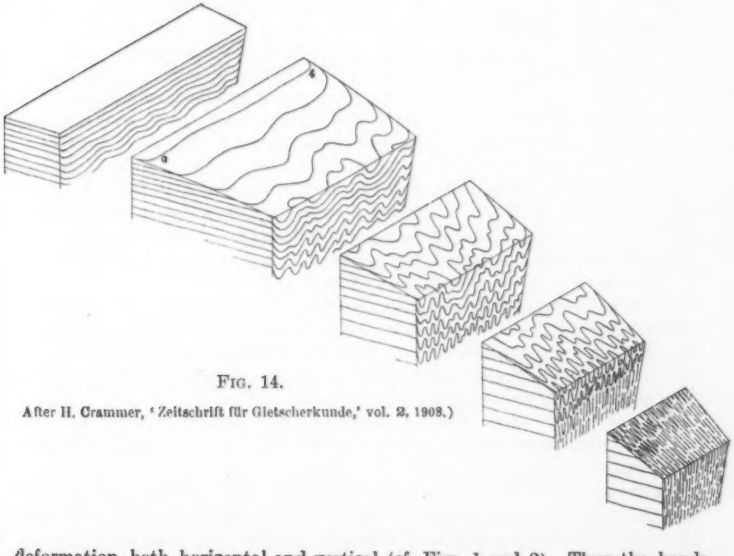


FIG. 14.

After H. Crammer, 'Zeitschrift für Gletscherkunde,' vol. 2, 1908.)

deformation, both horizontal and vertical (cf. Figs. 1 and 2). Thus the bands due to the scars of crevasses or shear planes also take a spoon shape near the

glacier foot. In Fig. 16, AEF is a longitudinal section of a glacier foot, ABCD shows the probable form which the bands would have if their upper parts were not removed by ablation. Between AG and BH are shown the successive positions of a transverse crevasse, and the curved lines beneath indicate the successive forms taken by a shear plane. Thus there are in the glacier tongue two

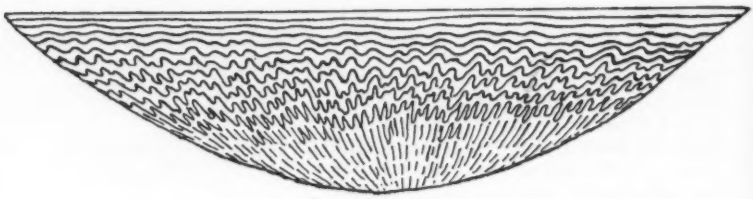


FIG. 15.

(After H. Crammer, 'Zeitschrift für Gletscherkunde,' vol. 2, 1908.)

distinct sets of bands which may have the form of spoons—the one, due to transverse crevasses, and the other, the transformed strata. The two sets often cut each other at very small angles.

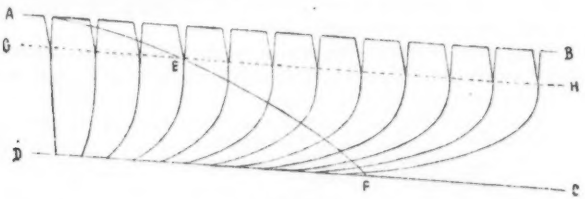


FIG. 16.

(After H. Crammer, 'Mitteilungen der Geographischen Gesellschaft,' Munich, vol. 4, 1909.)

S. Finsterwalder has recently described another type of *blätter*, or foliated structure in the ice, which he observed round the margin of a portion of the rock-bed, exposed by abnormal melting in the middle of the lower *névé* in the Vernagtferner. This foliation only appeared in the immediate neighbourhood of the rock-bed; it was very much contorted, and the leaves were from 1 millimetre to 5 millimetres in thickness. Finsterwalder thinks that this structure is produced quite independently of the *névé* stratification, and that it was probably the result of the movement. It may be considerably affected by the great local variations of pressure—due to differences in the thickness of the ice—which Finsterwalder believes to exist.

Theories concerning the Flowing Motion of the Ice.—There is a great difference of opinion with regard to the relation between the various ice structures and the movement of the glacier.

Hagenbach-Bischoff showed that the growth of the grains was due to the absorption by the bigger grains of the molecules from the smaller. Crammer has made experiments with the ice which he believes prove this to be true.

Below a certain depth the temperature of the ice is at the melting point which corresponds to the pressure. The differential motion must take place

either between separate molecules—almost as in the case of a liquid—or else between groups of molecules.

Hess and Crammer agree that movement can take place only in a very slight degree between the surfaces of the granules, which, through the greater part of their course, are interlocked in a most irregular way.

Crammer is of opinion that in the *névé* the movement takes place mainly between the strata, and in the tongue between the bands or "leaves" (Blätter). He believes the movement to be greatly facilitated by the thin layer of dust which frequently exists between the strata. This, he says, prevents the grains of one layer from joining ("überkrystallisieren") those of another.

This view is supported by a recent observation of S. Finsterwalder on the Vernagtferner. In a depression in the otherwise bare ice surface an unusually great accumulation of winter snow was seen. This never melted, and it formed a small "inlier" of *névé* in the dissipator. It had no structure except the stratification of successive accumulation. This included mass was being carried downstream with the velocity of the veined ice upon which it lay. The lower part of the inlier was found to be striped, in the direction of flow, by fine lines of darker colour, which proved to be the outcrops of vertical cracks, or faults. These faults in the included *névé* were in prolongation of the veined structure of the underlying glacier. This minute faulting can only have been produced, in the opinion of Finsterwalder, by a differential gliding motion along the surfaces of the "leaves" (*blätter*) below. This gliding motion appears to take place by fits and starts, and to be in intimate relation with the formation of crevasses.

The researches which E. v. Drygalski made upon the inland ice of Greenland led him to believe that the movement is principally due to variations in pressure. Successive changes of pressure produce melting and regelation, which facilitate motion in a mechanical and molecular way.

Hess remarks that the physicists have proved the quality of plasticity to exist in a crystal of ice undergoing deformatory pressure, and it has even been suggested that a glacier composed of a single crystal would be able to move in much the same manner as one composed of grains. According to Hess, "the plasticity which enables the ice to flow is a character depending upon the action of molecular forces, and is due neither to the grained structure nor to the temperature conditions, though it is favoured by both these circumstances."

R. M. Deeley, who has made extensive optical and other studies of glacier ice, believes the differential motion results from :—

(1) The viscous shear between adjacent granules.

(2) The viscous shear along planes at right angles to the optic axis of the granules.

(3) The plastic shearing of the granules into separate pieces, and to the viscosity imparted to the general mass by the growth of one crystal at the expense of another—*i.e.*, by the interchange of molecules from grain to grain.

R. F. Tarr during his investigations on the variations of glaciers—a subject too big for discussion here—has been led to the conviction of the viscosity of the ice, at least below a certain depth.

Both Hess and Deeley lay stress upon the importance, for glaciology, of the study of the alteration of form undergone by metals at ordinary temperatures.

Chamberlain and Salisbury advance the view that the gliding planes within crystals play a notable rôle in the movement only in the basal parts of the lower ends of glaciers, *i.e.* where the granules are most completely interlocked. In other parts there is differential motion between the grains. This motion in

the upper parts of the *névé* has no obstacle as the granules are more or less spherical and can slip over one another. The amount of relative change of position of the granules necessary to produce movement through the entire glacier is shown to be extremely small. This relative movement of the granules

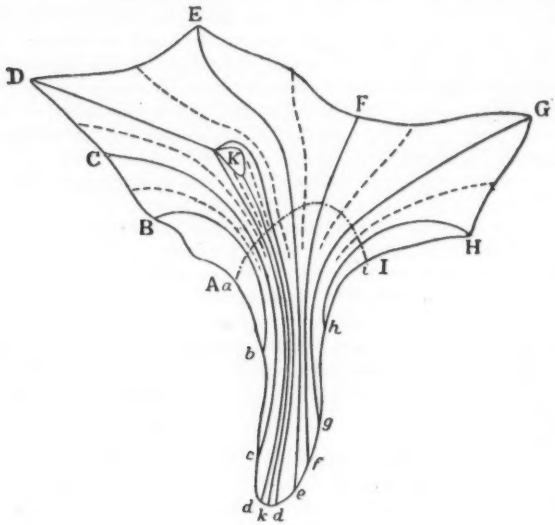


FIG. 17.

— · — · — · — = *Névé* line.

(After Finsterwalder, 'Zeitschrift des D.u.Ö. Alpenvereins, Wissenschaftliche Erganzungshefte,' vol. 1, No. 1.)

is chiefly due, they say, to the temporary passage of minute particles to the liquid state while the ice as a whole remains rigid.*

* For further information on properties of glacier ice, see the papers by J. Y. Buchanan mentioned in the Bibliography.

An account has recently been given (*Zeitschrift f. Gletscherkunde*, April, 1912) by the late Prof. Tarr and Dr. Rich of a series of experiments carried out by them on the properties of ice under pressure. No general conclusions are given by the authors, as the experiments were regarded as preliminary to further study, but among the many facts of interest which seem to be clearly demonstrated by the work, the following may be mentioned: (1) Ice which has undergone cutting by pressure, and subsequent regelation is optically undisturbed. (2) The deformation which ice undergoes when subjected to pressure is in the nature of plasticity; that is, a certain minimum stress is required for its initiation. Until this stress is reached there will be no permanent deformation. This plastic yield point lies near the breaking point of the ice. (3) The ease with which deformation may be produced varies with the direction in the crystal, and the effect of the deformation upon the optical properties also depends upon the direction. (4) Granular ice, composed of interlocking crystals, is subject to deformation equally with a single ice crystal. (5) In some directions the crystal will break by shearing before plastic deformation sets in. (6) Ice readily flows under pressure. (7) Snow can be changed to granular ice by pressure.

Transport of Moraine Matter.—The directions of movement in the different parts of the glacier ought to find illustration in the observed movement of moraine matter as given by the moraines. Finsterwalder's theory of moraines is the natural consequence of his theory of glacier flow (Figs. 6 and 7).

The rock *débris* which falls on to the *névé* margins passes along the bottom and is transported with the under-surface of the ice as ground moraine.* This material is ejected in the dissipator all round the margin and thus forms both lateral and terminal moraines. The lateral moraines are also in part composed of *débris* which has fallen upon the surface of the dissipator.

If there is an island in the reservoir, as K in Fig. 17, the *débris* formed there must follow the lines of flow downwards, and there will be no appearance of a line of moraine along the surface of the glacier starting from the island. On the other hand, where the material, coming from an island is situated either partly in the ablation area, as in Fig. 18, or wholly in it, the material that comes from the island will appear at once on the surface as a "medial" moraine, for the lines of flow are here coming to the surface. This medial moraine contains material both of the ground moraine and from the island.

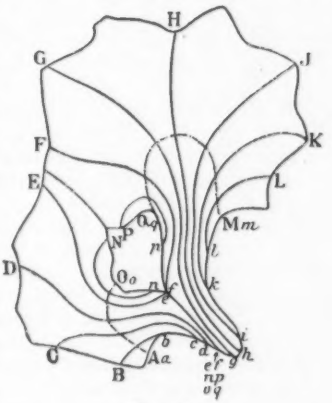


FIG. 18.

— · — · — · — · — = *Névé* line.

(After Finsterwalder, 'Zeitschrift des D.u.Ö. Alpenvereins, Wissenschaftliche Erganzungshefte,' vol. 1, No. 1.)

Applying to the case of the island in Fig. 18 the principle illustrated in Fig. 19, Finsterwalder's theory would explain the non-appearance of moraine on the surface of the ice leaving K, by its passing along the flow-line till that line, after crossing the *névé* line, eventually reaches the surface where the overlying ice has been melted away.

For a medial moraine to be produced it is not necessary that an excrescence of the bed should be visible at the surface. Fig. 10 shows flow-lines of three different tiers, selected in relation to a rock obstruction in the bed of a glacier. In (1) the flow-lines are those starting from the edge of the *névé* and passing along the bottom of the bed; the *débris* from the obstruction at this level passes along the bottom throughout (cf. Fig. 7), and emerges only at the glacier front at "ab." In (2) the flow-lines are those of a tier nearer to the surface of the glacier; the *débris* from the margin of the higher part of the obstruction that is here embraced emerges at "cd" where it becomes a surface moraine. In (3) the flow-lines drawn are those which just catch the tip of the obstructing prominence, well under the surface of the glacier; the fragments which come from "E" emerge as surface moraines at "e." Thus the medial moraine from "e" to "ab" at the foot of the glacier is formed by the emergence of internal moraine, beginning with that from the tip of the rock "E" and growing by later additions from successively deeper levels of the rock obstruction.

* According to those glaciologists who maintain that the glacier is an active agent of erosion, the ground moraine has in its composition material "plucked" from the glacier bed.

Considering the three sections together; from the rock edge BDE runs the internal moraine—a vertical wall of *débris* extending to the ground. The nearer this moraine gets to the glacier foot more and more of it appears at the surface. Thus, all surface medial-moraines which depend upon the ground moraine for their material must increase in bulk as they approach the glacier front.

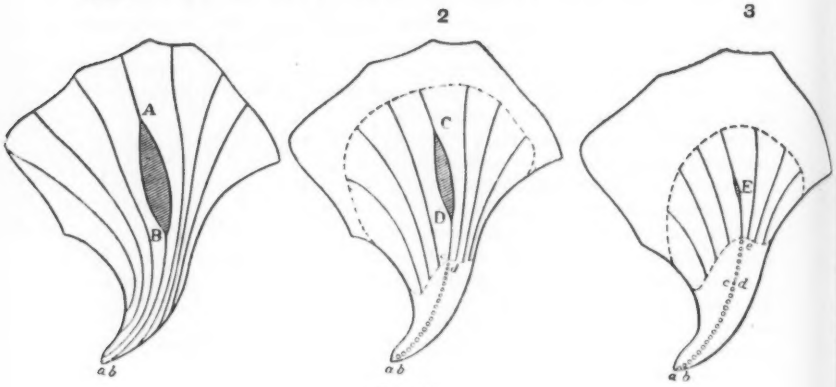


FIG. 19.

(After Finsterwalder, 'Zeitschrift des D.u.Ö. Alpenvereins, Wissenschaftliche Erganzungshefte,' vol. 1, No. 1.)

Fig. 20—from Hess—shows the positions of the various types of moraine in a cross-section near the glacier end. Transverse moraines (T) which sometimes form, come, according to Hess, from the ice-falls of steep steps in the glacier bed.

Crammer, in developing his theory above mentioned, suggests how some of

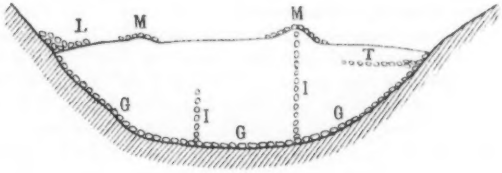


FIG. 20.

L = Lateral moraine.
G = Ground ,,
I = Internal ,,
M = Medial ,,
T = Transverse ,,
(After Hess, 'Die Gletscher.')

the ground moraine may become internal moraine. This material, he says, which is wedged into the lowest ice strata by vertical pressure, remains in the strata during their intense folding by the lateral pressure, and so eventually a bed of *débris*, formerly horizontal, may, like the strata, take up a vertical position.

BIBLIOGRAPHY.

L. Agassiz.—'Système Glaciaire.' Paris, 1847.

J. Y. Buchanan.—(*a*) "On Ice and its Natural History," *Proc. of Roy. Inst. of Gt. Brit.*, 1908, vol. 29.

(*b*) "Beobachtungen über die Einwirkung der Strahlung auf das Gletschereis," *Verhandl. der Naturf. Gesellschaft. Basel*, 1910.

(*c*) "In and around the Morteratsch Glacier," *Scottish Geog. Mag.*, April, 1912.

Chamberlin and Salisbury.—'Geology,' vol. 1, 1904.

Hans Crammer.—(*a*) "Ueber den zusammenhang zwischen Schichtung und Blätterung, und über die Bewegung der Gletscher," *Zentralblatt f. Mineralogie*, etc., 1902.

(*b*) "Eis und Gletscherstudien," *Neues Jahrbuch für Mineralogie*, etc. Supplement, 1903.

(*c*) "Ueber Gletscherbewegung und Moränen," *Neues Jahrbuch für Mineralogie*, etc., 1905; vol. 2.

(*d*) "Die Gletscher," *Aus der Nature*, 1906.

(*e*) "Ueber Klüfte im Firnfeld," *Zeitschrift für Gletscherkunde*, vol. 2, 1908, p. 61.

(*f*) "Zur Entstehung der Blätterstruktur aus der Firnschichtung," *Zeits. für Gl.*, vol. 2, 1908, p. 198.

(*g*) "Struktur und Bewegung des Gletschereises," *Mitteilungen der Geograph. Gesellschaft, Munich*, vol. 4, 1909.

R. M. Deeley.—(*a*) "The Structure of Glacier Ice," *Geolog. Magazine*, Dec., 1907.

(*b*) "Glacier Granule Markings," *Idem*, March, 1910.

(*c*) "The Structure of Glaciers," *Idem*, Oct., 1910.

(*d*) "Glacier Motion," *Idem*, Jan., 1911.

E. v. Drygalski.—(*a*) 'Die Grönlandexpedition der Berliner Gesellschaft für Erdkunde.' Berlin, 1897.

(*b*) "Spitzbergens Landformen," *Kgl. Bayerisch. Akad. der Wissenschaften*, vol. 25, 1911.

S. Finsterwalder.—(*a*) "Der Vernagtferner," *Deutsch und Oesterreichischer Alpenverein*. Scientific Supplement, 1. 1897.

(*b*) "Ueber die innere Struktur der Mittelmoränen," *Kgl. Bayerisch. Akad. der Wissenschaften*, vol. 30, 1900.

(*c*) "Beobachtungen über die Art der Gletscherbewegung." *Kgl. Bayerisch. Akad. der Wissenschaften*, 1912.

F. A. Forel.—"Structure Rubanée," *Zeits. f. Gletscherkunde*, vol. 1, 1906.

Hagenbach-Bischoff.—(*a*) "Das Gletscherkorn," *Verhandl. der Naturf. Gesellschaft Basel*, 1888.

(*b*) "Gletschereis," *Idem*, 1889.

A. Hamberg.—"Ueber die Parallelstruktur des Gletschereises," *IX. Congrès intern. de Géographie. Genève*, 1908. *Compte rendu*, t. II.

H. Hess.—(*a*) "Ueber den Zusammenhang zwischen Schichtung und Bänderung," *Neues Jahrbuch f. Mineralogie*, etc., 1902.

(*b*) "Probleme der Gletscherkunde," *Zeits. f. Gletscherkunde*, vol. 1, 1907.

(*c*) 'Die Gletscher.' Brunswick, 1904.

P. Mercaton.—'La III. Conférence Glaciaire Internationale,' *Archives des Sciences Phys. et Nat.*, Genève, 1905.

Ch. Rabot.—"Revue de Glaciologie, 1903–1907," *Mém. de la Soc. Fribourgeoise d. Sciences Nat.*, V.

H. F. Reid.—(*a*) "The Mechanics of Glaciers," *Journal of Geology*. Chicago, 1896.
(*b*) Compte Rendu du VIII., Congrès Geolog. Internat. 1900. Paris.
(*c*) „ „ IX. „ „ „ 1903, Vienna.
(*d*) "Flow of glaciers and stratification," *Appalachia*, XI.

R. S. Tarr.—"Theory of Advance of Glaciers in Response to Earthquake Shaking," *Zeits. f. Gletscherkunde*, V., 1910.

R. S. Tarr and J. L. Rich.—"The Properties of Ice—Experimental Studies," *Zeitschrift für Gletscherkunde*, vol. 6, 1912, p. 225.

THE ATLANTIC AND PACIFIC TYPES OF COAST.

By E. H. L. SCHWARZ, A.R.C.S., F.G.S., Rhodes University College, Grahamstown, South Africa.

Prof. J. W. Gregory has recently * drawn attention to apparent contradictions in Prof. Suess' definitions of the two main types of coast exhibited on the globe, and the result of his inquiry is that, according to him, the original definitions should be modified. Taking the coast-lines of the world one by one and examining their history and position, it would appear that Prof. Suess' definitions explain so much and are so illuminating that it seems a pity to discredit them by bringing to bear on the question, which is one of broad outline, details which confuse the issue. According to Prof. Suess, the Atlantic is bordered by folded mountain chains which run out to sea and are cut off by the coast-line; the Pacific by folded mountain chains which run parallel to the coast-line. In addition, the folds of the Atlantic expose their backs to the ocean, and those of the Pacific their fronts; in other words, if the range is composed of Archæan, Palæozoic, and Mesozoic strata, the old Archæan base is exposed on the Atlantic side and the youngest strata on the Pacific side. A good example of this latter fact is represented by New Zealand and South Africa. In South island in New Zealand the folded ranges come from the north-east and meet on the south-west in a knot or *Schaarung* with the folds which come from the south-east. In the embrace of the folds lies a plateau of Mesozoic strata corresponding to the Karroo beds of South Africa, whereas on the side of the island facing the mainland—that is, Australia—the Archæan base is exposed. In South Africa the exact reverse is represented; the Karroo beds lying in the angle of the Schaarung are inland, and the Archæan base of the coastal mountains faces the open ocean.

There is, however, water between New Zealand and Australia; that is, the true continental border of the western side of the Pacific is partly

* "The Structural and Petrographic Classifications of Coast-Types," *Scientia* vol. 11, 1912.

drowned and separated from the adjoining land. It is the purpose of this paper to show that the western borders of both the Pacific and Atlantic are drowned, whereas the eastern are elevated. The most convenient way to study the question is to take similar geographical units, such as the Mediterranean and the Caribbean seas, South Africa and South America for the Atlantic, and the Rocky mountains and the festoons of islands in front of China for the Pacific. These are described in detail in Prof. Suess' 'Antlitz der Erde,' and if it is conceded that the western sides of the oceans are drowned, then the need of a redefinition of the types of coast-lines becomes unnecessary. Why the western sides are drowned is that as the Earth continually is revolving from west to east under the sun, the attraction of this latter upon the outstanding ridges of the Earth's crust causes them in the course of ages to shift gradually from east to west, so that the eastern sides of the ocean basins are advancing and the western retreating. This secular earth-creep has not hitherto been universally recognized, as it was obscured by the theory of the permanence of ocean basins, which for a long time was accepted as a proven fact. If it be true that the Earth revolves and that matter attracts matter, then secular earth-creep must be a necessary consequence; but it is not the purpose of this paper to discuss causes, but rather to draw attention to effects.

The Mediterranean and Caribbean Seas.—The Mediterranean sea from the Gulf of Gabes to Gibraltar is bordered by the Atlas mountains; the folds turn round, pass into Spain across the Straits of Gibraltar, thence turn east-north-east in the folded ranges of Southern Spain, the Betic cordillera, through the Balearic islands to the Gulf of Genoa, thence down Italy in the Apennines and through Sicily to the Gulf of Gabes. A further portion, also between folds, is delimited by the Dinaric Alps, Mount Pindus, and the folds which thence run through Candia and Cyprus. The region between Sicily, Candia, and Cyprus and the Tripoli and Egyptian coasts lies in a sunken area of the plateau of Africa.

The Caribbean sea is surrounded by folded chains which trend from Yucatan through Cuba, Hayti, and the Lesser Antilles to Trinidad, thence westwards through the coastal ranges of Venezuela to the Lake of Maracaibo, and from here south-west to join the Andes. On the north-west, beyond Yucatan and Cuba, lies the Gulf of Mexico, which is a sunken portion of the plateau land of North America, similar in nature to the Mediterranean in the Tripoli and Egyptian areas.

The nature of the folds is of the Atlantic type in both cases—that is, Archæan on the seaboard and younger sediments inland, and, in addition, a chain of volcanic islands on the outer margin in the Archæan region. Taking the north coast of Africa as typical of the nature of the Mediterranean folds, we find gneiss and granite in the Great Kabylia, west of the Bay of Bougie, in Cape Matifon and Bouzarea, in the Bay of Algiers, at Oran and Melilla. The little islands off the coast consist of volcanic rocks, basalt, and trachyte, such as the islands Galita, Habibas, Raschgoun, and the

Zaffarin islands west of Nemours. Carboniferous rocks lie upon the gneiss in Oran; elsewhere the stratigraphical series begins with a red Permean series. Trias, Lias, Juras, and Eocene beds follow the last, and of these the folded Atlas mountains are composed. The same arrangement is observed in the other circum-Mediterranean folds, although frequently one or more members of the series may be left out.

In the Caribbean sea, owing to the submergence of the folds, it is difficult to find a place where the sequence can be studied. In the south of Cuba, however, the Sierra Maestra shows granite in the south, where it descends steeply to the sea. Elsewhere the granite base is submerged, and only the overlying Cretaceous and Tertiary beds appear, the younger on the convex outer arc of the islands, and the older beds on the inner side. In the lesser Antilles there are three zones, the innermost entirely of volcanic origin, and including the islands Saba, St. Eustatius, St. Christopher, Nevis, Redonda, Montserrat, the inner half of Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, the Grenadines, and Grenada. The middle zone consists of the islands of Cretaceous walls and some Tertiary beds, and includes St. Croix, Anguilla, St. Bartholomew, Antigua, the eastern part of Guadeloupe, and part of Barbados. The outermost zone consists of low islands of quite late Tertiary beds, and includes the Bahamas, Natividad, Anegada, Sombrero, Barbuda, and part of the Barbados.

Both the Caribbean and Mediterranean seas, therefore, lie within a loop of folded mountains, with a coast-line of granite in which volcanic vents are situated. Above the granite are sedimentary beds, the youngest outermost; but whereas the Tertiary beds of this outer zone in the case of the Mediterranean stretch out over Europe and Africa, in the case of the Caribbean they are for a large part turned towards the open ocean which has swamped all but a few remnants—the Atlas, the Betic cordillera, the Apennines, and Dinaric Alps form solid mountain chains which are part of the great continents; on the western side of the Atlantic their counterparts are represented by a chain of islands, and even then in many cases the existence of the folded chain is only indicated by the volcanoes which have piled up their cones sufficiently high to reach above the water. In the Mediterranean the chains of mountains have formerly been isolated by water, and only recently have they become joined into a continuous mass with the continents, as the deposits of late Tertiary beds at their foot indicate; in the Caribbean sea the chains have every indication that they were not long ago continuous, but that now they are drowned, and the highest peaks alone are above water.

South Africa and South America.—The western portion of South Africa is a fractured tableland with Mesozoic folding superadded. South America is a simple fractured tableland on the eastern side. In South Africa there is the Archæan basis with granite and gneiss; above comes the Cape Formation beginning with a great sandstone series, then slates with Devonian fossils, and above another sandstone series with Lower Carboniferous

fossils. On top are the Karroo beds with *Glossopteris*. In South America there is the same sequence; granite and Archæan rocks forming the bases of the coastal regions, then a great step composed of sandstones thousands of feet thick with intercalated shales on top with Devonian fossils, and the Santa Catharina Beds with *Glossopteris*, corresponding to the Karroo beds, lying on the Archæan as in the north of Cape Colony. The Santa Catharina Beds apparently only occur in the coastal districts of Southern Brazil; the whole region represented by the south-western portion of Cape Colony on the east of the Atlantic is foundered beneath the ocean on the west, and only a remnant appears in the Falkland islands. In these islands the typical South African sequence is found; there are Devonian rocks with fossils identical with Brazilian and South African species, Lower Carboniferous fossils in the succeeding beds, and the usual types of fossils associated with *Glossopteris* in the rocks above.

Below the Falkland islands is a loop of folded mountains similar to that which circles round the Caribbean sea. The southern portion of South America turns sharply to the east, and the continuation of the folds is found in South Georgia, thence it sweeps round through the Sandwich group, back through the South Orkneys, to Graham Land. The southern border of the Karroo rocks in South Africa was some distance south of the present coast-line, and it was formed by a prolongation of the Madagascar ridge, but there is nothing above sea-level to the south of South Africa now to enable one to reconstruct the nature of this lost land; at any rate, there does not appear to have been much relief in the old land-surface, and hence there were not sufficient outstanding ridges for the attraction of the sun to act upon. In the Northern Atlantic, again, there is so much land that differential movement, due to ridges following the sun, would be small; as a matter of fact the vigorous forward movement of the Mediterranean area, and the backward one of the Caribbean area, seems to have resulted in a back wash in the North Atlantic, for in the two similar geographical units, the Hudson bay area and the Baltic area, it is the Baltic area that is drowned and the Hudson bay area which lies deep in the land. Scandinavia is now rising, and the anomaly appears to be in the process of disappearing. Secular earth creep, as a rule, would only be noticeable where a marked ridge like Africa or America runs longitudinally across the globe.

The Northern Pacific.—The Northern Pacific is bordered by the straight coast-line of North America on the east and by festoons of islands on the west. The eastern border begins with the Rocky mountains which bound the prairies on the west. Then westwards there are the plateaux of Utah and Colorado, forming a sort of gigantic gridiron of elevated strips with steep fault-valleys between, then the Sierra Nevada, and finally the coast ranges of California; all these are connected and form part of the mainland. On the western side of the Pacific the coastal ranges are submerged and are represented by the Loo-Choo, Japan, and the Kurile

islands with Kamchatka. The actual border of the mainland is composed of an inner chain corresponding to the Rocky mountains on the east, the intervening country having been submerged. One of the most instructive instances here is the Sechota-Alin, which is all but separated from the mainland by the lower Amur and its tributaries and by a number of lakes, and by Peter the Great bay on the south and Ulban bay on the north; it looks almost like a portion of the continent just about to float away and form one of the detached island festoons in the advancing of the ocean westwards. In geological features there is a difficulty here. On the western side of the Atlantic the Mesozoic is completed towards the ocean, and is capped on the outside by Tertiary beds as in the usual Pacific type, but on the eastern side there are mica-schists and granite on the coast. This feature is a constant one right down the coast of the Americas to Tierra del Fuego; in the last place, Darwin, in 1851, in his observations on South America (p. 239) remarked that the Cretaceous took on a Palæozoic aspect, and (p. 154) he says, "I am tempted to believe that where the clay slate (of which the Cretaceous rocks are here composed) has been metamorphosed at great depths beneath the surface, gneiss, mica-slate, and other allied rocks have been formed." This view is shared by many American authors, and Whitney contends that the granite, at any rate, is of Tertiary age, and other authors ascribe a like age to the mica-schists. Certainly the sequence of the beds in California, with their great bands of Serpentine, recall the Cretaceous rocks of Hayti and Cuba, or of Cyprus, only that the mineral constituents have been recrystallized. If these metamorphic rocks are taken as Archæan, as Prof. Gregory does, then the whole structure of the American continent becomes obscure and Prof. Suess's definition of Pacific type of coast-line misleading. If, on the other hand, it be conceded that the metamorphic rocks are Mesozoic, then the Tertiary rocks lying upon them complete the series towards the ocean as they do on the other side of the Pacific, and the broad structure of this part of the world becomes plain.

In the Indian ocean the same drowning of the western border may be seen, but here only half the length of the continental ridges is exposed to the ocean, the northern halves are merged into a solid whole by the transverse ridge of the Himalayas and associated chains; nevertheless, in the east, Australia thrusts out a broad mass to the west, as does Africa and South America, and on the western side of the Indian ocean there is the drowned land of which Madagascar, Mauritius, Rodriguez, the Seychelles, Comoro islands, and Aldabra are the remnants.

The net result of the application of the theory of secular earth-creep is that coast-lines are advancing on the east and retreating on the west of the oceans. Although the simple conception of Prof. Suess that a Pacific type, for instance, has folded ranges parallel to the coast, is frequently found to be erroneous in certain localities, this is accounted for by the movement which, owing to local resistance in the Earth's crust, may disturb the

arrangement. Again, the true Pacific type of coast-line in the drowned western side is not found in the coast-line of the mainland, but in the fringe of islands off the coast. The ultimate simplified conception of the two types of coast-line implies that the Pacific is a broad qua-qua-versal syncline like a dent in a ball, whereas the Atlantic is a bulge, the centre of which has given way along faults, so that the ocean basin lies between fractures. The full and complete exposition of this structure existed in late Tertiary times, but since then secular earth-creep has been modifying the outlines; enough, however, remains to bear witness of the truth of the brilliant generalization of Prof. Suess.

ON THE CAUSE OF THE JAMAICA EARTHQUAKE OF JANUARY 14, 1907.

By VAUGHAN CORNISH, D.Sc., F.R.G.S., F.G.S.

THE *Geographical Journal* for March, 1908, contains an account of my experiences at Kingston during the Jamaica earthquake of January 14, 1907, and the results of my investigations in Jamaica in May–July of the same year. A map is appended to that paper showing in detail the relative intensity of the shock in different parts of the island. The outstanding feature of that map is the narrow zone crossing the island at its narrowest part between the lines Harbour Head to Buff Bay on the east and Port Royal to Enfield on the west. This was the zone in which buildings fell. It was generally in the eastern half of the zone that the damage was worst.

From the evidence of the earthquake itself, combined with that of the after-shocks, I came to the conclusion that there were two regions from which the tremors of the earthquake originated, viz. one near the shore south-of-east from Kingston, and the other, less precisely located, in the mountainous region within the triangle formed by the points Newcastle, Buff Bay, and Glengoffe.

In the above-mentioned paper I did not attempt to describe further how the earthquake was brought about. That there was fracture or faulting of rock near Harbour Head, and probably also somewhere in the neighbourhood of Hardware Gap, I take to have been pretty well established by the facts I set out, but I was not able at the time to discover evidence of any physical action by which these fractures had been produced.

It 1907 I had looked for a subterranean agent, and my attention was fixed on the geological map and sections, upon the outcrop of strata, the folds of the mountains, and the position of known faults. The conclusion I came to was that the earthquake had shown a cynical disregard for these things.

Further, if we were to suppose that the island was being folded or

faulted along a new structural axis running from west of south to east of north, from near Kingston to near Buff Bay, then the earthquake must have resulted from a process descending deeply into the bowels of the Earth, and its effects would have been very marked at great distances. Now, one of the outstanding features of the earthquake was that, although violent on the spot, its intensity fell off very rapidly. Indeed, the small record of seismographs in England led to the statement that the first telegrams of the disaster were probably exaggerated.

After spending the month of August, 1910, in Jamaica, I realized that there was an agent visibly at work which could have produced the whole of the effects of the earthquake of 1907, and that the agent was superficial, not subterranean. I saw that the whole thing could have been produced by the redistribution of load by the existing rivers flowing in their present courses. The map which is wanted for understanding the Jamaica earthquake is that of the modern orography more than that of the solid geology.

Orographically, Jamaica consists essentially of two parts. First, there is the eastern third of the island traversed by a ridge of mountains, largely of conglomerate rock, rising to 7000 feet, with sharp-edged spurs and narrow valleys between. Secondly, there is the western two-thirds of the island, which is largely a limestone plateau nowhere exceeding 3000 feet, with "cockpits," dry valleys, sinkholes, and underground rivers.

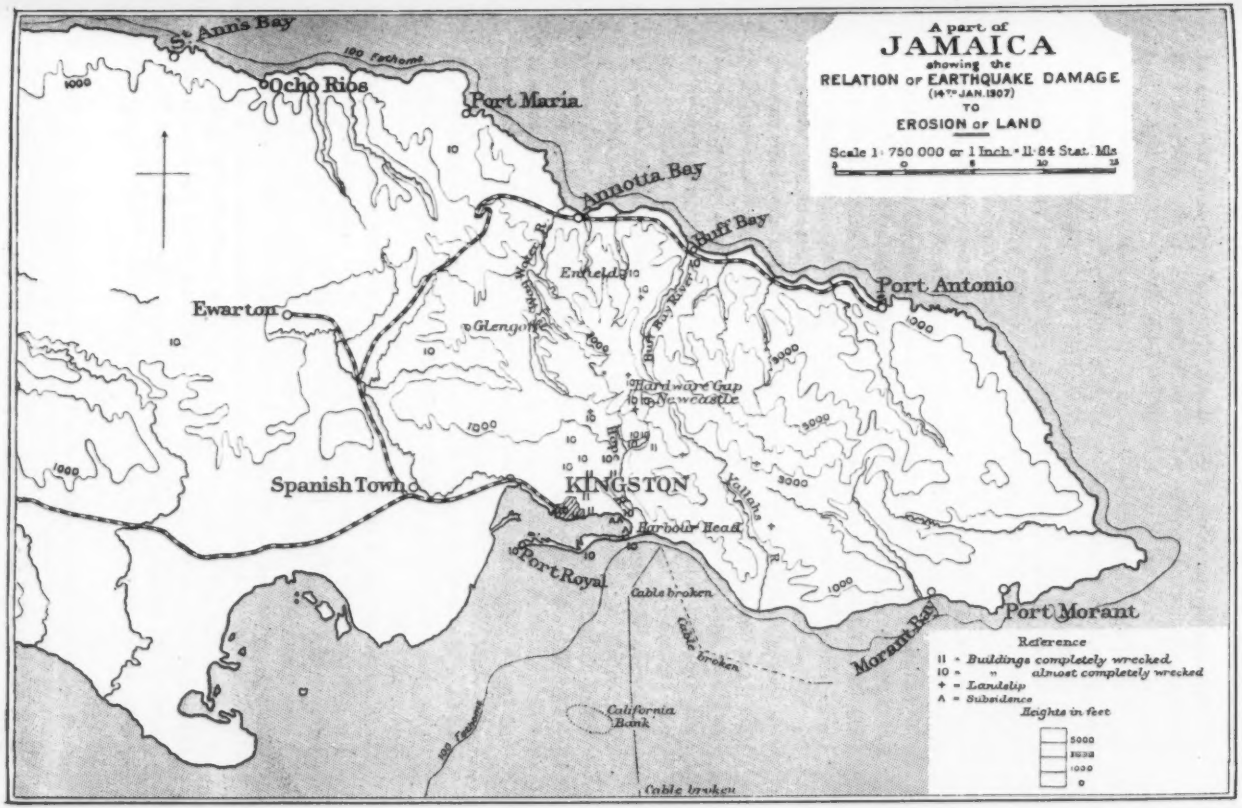
The whole of the zone of greatest intensity of the earthquake lay in the eastern third of the island.

In this eastern part of the island there is one region which far exceeds all others in orographical importance, viz. the region of the Gaps (Hardware Gap, etc.), which is the great radiant point of rivers. Thence the Hope river flows south. The descent from the mountains above its source to its mouth is 5000 feet in about 11 miles. The Buff Bay river descends to the north a similar amount in a similar distance. Thence also the Wag Water and other rivers flow to the north-west, and the Yallahs river and others to the south-east.

The zone of greatest earthquake damage is parallel to the line of the Hope river and Buff Bay river, and on its eastern margin coincident with them.

The region already specified in 1908 as that of the southern origin of earthquake tremors is close to the delta of the Hope river.

The region already specified in 1908 as the area from which another set of tremors probably originated is that of the headwaters of the above rivers, at which place, and at which place only, the eastern mountains are so cut into and eaten away by weather that their residual ridges form a knot, with a network of radiating valleys. Here, too, is the only place where the main range has been so eaten into that a road has been carried across it from south to north.


A part of
JAMAICA
showing the
RELATION OF EARTHQUAKE DAMAGE
(14TH JAN. 1907)
TO
EROSION OF LAND
Scale 1 : 750 000 or 1 Inch = 11·84 Stat. Mls
St. Anns Bay
100 fathoms
Ocho Rios
Port Maria
Annotto Bay
Buff Bay
Port Antonio
Ewarton
Enfield
Glengoffe
Hardware Gap
to Newcastle
Spanish Town
KINGSTON
Harbour Head
Port Royal
Cable broken
Cable broken
Cable broken
Port Morant
Morant Bay
California Bank
100 fathoms
Reference
11 = Buildings completely wrecked
10 = " almost completely wrecked
+ = Landslip
A = Subsidence
Heights in feet
5000
1000
0

The map in the *Journal* for March, 1908, shows that the area of moderate damage (force 9, where walls, but not whole buildings, fell) extends on the south coast eastwards of the mouth of the Hope river to that of the Yallahs river, and on the north coast westwards of the zone of greatest damage along the debouchures of the Wag Water and other rivers originating in the neighbourhood of the Gaps.

My theory of the cause of the earthquake is that it was due to a disturbance of pre-existing equilibrium by this modern redistribution of load, that the southern tremors came from subsidence with fracture at sea near the mouth of Hope river, and that the northern tremors were produced by elevation with fracture near the Gaps.

The above theory was suggested to me by what I saw in 1910 of gravitational movements resulting from redistribution of load on the Panama canal works. In many landslides which occurred on the canal banks there was an area above where there was subsidence with fractures of the surface, and, at the lower end, an area of upheaval also with fractures of surface.* Between there was no fracture of the surface. Here there was no movement perpendicular to the original surface. The subsidence had a concave surface, and the elevation a convex surface. Thus gravitation, in causing the land to slide, did not reduce a steep plane surface to a flatter plane surface, but (while diminishing the average gradient) converted the form of the surface to that of a single wave, with trough, node, and crest, *with fractures at trough and crest.*

This is how gravity reduced the slope of materials not under stress, but standing too steeply for their weight, cohesion, and internal friction. In the case of the Eastern Jamaica mountains, I assume that there is still stress (originating, presumably, in a neighbouring subsidence of earlier date) from which a squeeze is transmitted horizontally. The elevation of coastal platforms of corals quite similar to the fringing reef shows that there has been stress exercised on Jamaica in the most recent geological times.

Thus the action of the rivers flowing south and north from the Gaps has put the profile of the island at this part of its cross-section out of regimen with the stress. To the east and west in the eastern third of the island, where the redistribution of load by weathering of the mountains has been less emphatic, equilibrium is still maintained. Along the south coast near the mouth of the Hope river, and for some miles south thereof, I suppose the horizontal squeeze to have been insufficient to hold up the added load, and that a subsidence took place, with fractures which produced the tremors by which Kingston was wrecked. Near the headwaters of the rivers in the mountain area about the "Gaps," I suppose

* See *Journal Royal Society of Arts*, December 9, 1910, paper by the author on "The Panama Canal in 1910." I have proposed the name "isostatic landslide" for the occurrence, see a paper on "The Panama canal and its Relation to the British Empire," read at the Royal Colonial Institute, June 11, 1912.

the diminished weight of the mountains to have been insufficient to hold down the surface against the squeeze (with the impetus from the southern subsidence added *), and that an elevation immediately followed, with fractures which sent out the tremors by which stone villas and churches were wrecked, roads were fissured, and landslips produced in the surrounding neighbourhood.†

There is this much connection with the petrology, that the ridge of the eastern mountains is much eaten into where it is crossed in this neighbourhood by the friable Richmond beds.

Equilibrium is now, presumably, restored, and as the redistribution of load by rain and rivers is small in one year, or five years, or even ten years, there should be no recurrence of severe earthquake from the same cause in this region for a long time to come. There was no very severe earthquake in the neighbourhood of Kingston between 1692 and 1907. It is impossible, from lack of data, to say if the earthquake of 1692 were caused in the same way as that of 1907; but, at all events, the redistribution of load by rivers occasioned no great earthquake for two hundred years before 1907.

It may be a satisfaction to those interested in the island to understand these reasons for thinking that the recent earthquake was caused by a familiar, everyday, agency, which we can see at work, and which operates at a slow and fairly regular rate; and not by any gigantic and deep-seated cause, unlimited in its possible powers of destruction, and liable, for aught we know, to act destructively at any moment.

I have only to add that I had, in 1910, the advantage of again discussing the earthquake with my friend, Mr. John D'Aeth, I.S.O., Assistant Director of Public Works, whose intimate knowledge of the topography of Jamaica was of great help to me. I remember, in particular, that he stated his opinion that the greatest severity of shock nearly coincided with the line of the Hope and Buff Bay rivers.

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* The rise might come first, but at Kingston, at any rate, the first shaking came from the southward.

† The stripping of the upper slopes of the eastern mountains by weather is intermittent, occurring after heavy rains, when patches of the shallow soil, acres in extent, slide into the deep and narrow valleys. Lower down the watercourses, and also on the Linguinea plain itself, large deposits of boulders and gravel are left by flooded rivers. In 1910 I saw both things on a large scale as a result of the great rains of the preceding autumn.

THE DISTRIBUTION OF EARLY BRONZE AGE SETTLEMENTS IN BRITAIN.*

By O. G. S. CRAWFORD.

APPENDIX.

GOLD LUNULÆ.

[I am much indebted to the curators of the museums and owners of collections quoted in the following lists, for information with regard to the sites of discovery, and for other assistance. It has obviously been impossible to acknowledge such help in each instance in the lists, and I take this opportunity of thanking all very sincerely for their kindness and courtesy.]

Site of discovery.	References.	Present abode.	Remarks.
ENGLAND.			
Cornwall—			
Harlyn, Merryn, Padstow	A.J., **22**, 1865, p. 277; Evans, A.B.I., p. 42; V.C.H. Cornwall, **1**, p. 356; T. Rice Holmes, 'Ancient Britain,' 1907, p. 165; J. Déchelette, 'Manuel d'Archéologie,' **2**, 1910, p. 354; *J.R. Inst. Corn.*, **2**, 1866–7, p. 142, two plates	Truro Mus.	Two, found with a flat celt.
St. Juliot, Hundred of Lesnewth	A.J., **22**, 1865, p. 276; *J.R. Inst. Corn.*, **2**, p. 135	Unknown, but believed to be in existence	
*Hundred of Penwith	*Minutes of the Soc. of Antiquaries*, 1783; A.J., **3**, 1846, p. 37	Brit. Mus.	This is probably the same as the one below from Penzance, which is in the Hundred of Penwith.
Penzance	S. Lysons, *Magna Britannia*, **3**, 1814, p. ccxxi. pl. 14	Brit. Mus.	Found in 1783 "near the remains of one of the circular earthworks in the neighbourhood of Penzance." In possession of Rose Price in 1814.
WALES.			
Carnarvonshire—			
Tyr Dewin Farm, Llanllyfni		Brit. Mus.	
SCOTLAND.			
Dumfriesshire—			
Auchentaggart, Sanquhar	Anderson, **1**, 1883, p. 222	Edinburgh Mus.	
Elginshire—			
Fochabers	'Cat. Nat. Mus. Ants., Scot.,' 1892, p. 210	Edinburgh Mus.	Found in 1873.
Lanarkshire—			
Southside, Coulter	Anderson, **1**, 1883, p. 223	Edinburgh Mus.	Two.
IRELAND.			
Antrim—			
Cairnlochran, Maheramesk	*Dublin Penny Journal*, **4**, p. 295		Three found together in removing a fallen cromlech stone.

* Continued from page 203.

Site of discovery.	References.	Present abode.	Remarks.
Armagh—			
Tartaraghan	*Ulster Journal of Archæology*, **9**, p. 47	Cecil, Augher	
Cavan—			
Lisanova, Bawnboy	*Prähistorische Zeitschrift*, B. **3**, 1911, p. 184; *Irish Times*, July 8, 1910	Dublin Mus.	
Bailyborough		Brit. Mus.	
Newtown, Crossdoney		Dublin Mus. [Bought in April, 1884]	Found in a bog, 6 feet deep, between two oval slabs of oak.
*Exact site not known		Brit. Mus.	Weight 1 oz. 11 dwt. 4 grs.; width, 8·6 ins.
Clare—			
Carrowduff, Ennistymon		Dublin Mus.	Found in a bog, May, 1877.
Porsoon Callan		Dublin Mus. [1887 : 52]	
*Reyhole	Gough's Camden, **4**, p. 230; *Ulster Journal of Archæology*, **9**, p. 46		Found in a ditch.
*Exact site unknown	*Proc. R. Irish Acad.*, **8**, 1864, p. 83, fig. 1	Unknown	
Cork—			
Ballycottin		Brit. Mus.	
*Exact site unknown	"Shown in a drawing by the late Mr. Brash in a scrap-book of Mr. Clibborn's in R.I.A. Library" (Frazer)	Unknown.	Found in 1867. Width, $8\frac{1}{2}$ ins.; height, $7\frac{3}{4}$ ins.; breadth (at top), $2\frac{5}{8}$ ins. Perhaps another figured.
Donegal—			
Ardara	Miscellanea Graphica, pl. 17	Unknown	Shown with Lord Londesborough's Collection at Dublin Exhibition, 1872; and sold with rest of collection, May 9, 1884.
Naran		Dublin Mus. [1909 : 6]	
Trenta, Carrigans		Dublin Mus. [1889 : 20]	Found in May, 1886, under a boulder, with a large flint arrow-head.
Down—			
Barony of Castlereagh	Statistical Survey of the County of Down, by John Dubourdieu, 1802, p. 301	In possession of the Downshire family in 1802	Found in a bog a few years before 1802.
Fermanagh—			
Enniskillen		Collection of Mr. Robert Day, Cork.	Found under 20 feet of peat.
Galway—			
*Exact site not known	Wilde, p. 16	Dublin Mus. [W. 10]	
Kerry—			
Banmore, Kilmoyly, barony of Clanmorris		Dublin Mus. [R. 1755, 1756, 1757]	Three, found together.
Killarney	'MS. Minute-book of Committee of Antiquities,' **1**, p. 50 (R.I.A.); Wilde, p. 11, fig. 538	Dublin Mus. [W. 2]	Presented to the R.I.A. in 1778 by Lord Kenmare.
Mangerton	*Ulster Journal of Archæology*, **9**, p. 47	Brit. Mus.	Found in 1842. Formerly in possession of Sir Thomas Tobin.
Kildare—			
Dunfierth, Carbury	Wilde, pp. 15, 16	Dublin Mus. [W. 4. 8. 9. 15.]	Four, found together in hard gravel, apparently the remains of an ancient road through a boggy field.

Site of discovery.	References.	Present abode.	Remarks.
Londonderry—			
Dungiven	Mason, 'Statistical Account of Ireland,' 1, p. 304	Unknown	Found in March, 1814, in removing a tree. Height, 7 ins. to 8 ins.; greatest width, 1½ ins.
*Exact site unknown		Dublin Mus. [W. 12]	
*Exact site ununknown		Dublin Mus. [Loan, 1907: 7]	
Mayo—			
*Exact site unknown		Dublin Mus. [1909: 4]	
Monaghan—			
Ballybay		Collection of Mr. Robert Day, Cork	
Sligo—			
*Exact site unknown	Windele's Sketches in Library R.I.A., volume 'Miscellanea,' p. 206	Unknown	Found in March, 1847, in a bog. Weight 1 oz. 6 dwt. 11 grs.
Tipperary—			
Glengall, Ballingarry		Brit. Mus.	
Tyrone—			
Carrickmore		Dublin Mus. [1900: 50]	
*Exact site unknown	Campbell's 'Philos. Survey of Ireland;' *Ulster Journal of Archæology*, p. 47	Unknown	Found in a bog.
Trillick		Dublin Mus. [1884: 495]	Found on a mountain near a "Danish fort" under a large rock.
Westmeath—			
Athlone	Wilde, p. 17, fig. 549; P.R.I.A., 2, 1844, 274	Dublin Mus. [W. 5]	Found in 1842.
Athlone		Dublin Mus. [1893: 4]	Found in 1848. No. 143 of the Bateman collection. [Two according to Coffey.]
Mullingar		Dublin Mus. [1884: 7]	Found before 1820.
Ross, Kilkenny West		Dublin Mus. [1896: 15]	Found near the shores of Lough Ree, about ½ mile from a ruined castle named Ballynacliffy.
FRANCE			
Côtes du Nord—			
Saint Potan	'Rev. Celt.,' 21, 1900, p. 95; 'C.A.F. Beauvais,' 1905	Collection of M. Paul du Chatellier	Found in 1890 by quarrymen.
Manche—			
Between Montebourg and Tourlaville	*Mém. Soc. Ant. Normandie*, 1827–8, p. 273; 'C.A.F. Beauvais,' 1905, p. 301	Melted down	Two, one at least a lunula. Drawings in Cherbourg Museum. Found about 1790, 2 kilos from Mont Castre.
Saint-Cyr	A. de Caumont, *Cours d'Antiq. Monumentales*, 1, p. 243, pl. 10, fig. 4; 'Rev. Celt.,' 21, 1900, p. 95; 'Anthr.,' 5, 1894, p. 205, fig. 1	Melted down	Three found about 1805, and melted down. One only was drawn.
Vendée—			
Bourneau	'Rev. Arch.,' 2, 1879, p. 255		

Site of discovery.	References.	Present abode.	Remarks.
Vendée (contd.)—			
Nesmy	'Rev. Celt.,' 21, 1900, p. 95; Déchelette, 'Manuel,' 2, App., p. 5 (No. 15)		Large hoard all lost. Found 1759–1760.
BELGIUM			
Luxembourg—			
Fauvillers	'C.A.F. Beauvais,' 1905, p. 302		
DENMARK			
Zealand—			
Grevinge, Odsnarde	A.F.A., 19, 1891, p. 9	Copenhagen Mus. (No. 101)	
Fünen—			
Skovshöierup, Näsby Hoved, Broby	A.F.A., 19, 1891, p. 8, fig. 7	Ditto (Nos. 3, B. 3596 and B. 3705)	
GERMANY			
Hanover—			
Schulenburg, on the river Leine	By letter from the Direktion des Prov.-Museum, February 9, 1912	Prov.-Museum, Hanover.	

FLAT COPPER AND BRONZE CELTS.

1. ENGLAND.

Berkshire—			
Long Wittenham		Oxford A.	
Cholsey		Reading Mus. (A. L. XLV.)	Found near the church in ploughing.
Cholsey		Reading Mus. (A. L. XLIV.)	
Newbury	J.B.A.A., 1, 1846, p. 337 (?)	Newbury Mus.	It is not certain whether the celt here described is the flat celt now in the Newbury Museum. It was exhibited by Mr. John Purdue, and said to have been found "on a gravel heath to the north of Newbury."
Cambridgeshire—			
Fordham		Cambridge Mus.	Herriard type.
"		Ditto	
"		Ditto	
"		Ditto	
Bottisham Lode		Ditto	
Near Cambridge		Ditto	
Quy		Ditto	
Hauxton		Ditto	
Duxford	*Arch. Jour.*, 7, p. 179; Evans, p. 43	Ditto	
Reach Fen		Collection of Mr. Henry Backhouse, Bournemouth	Found in May, 1862.
Cheshire—			
Grappenhall	*Arch. Jour.*, 18, p. 158; Evans, p. 43; W. Shone, 'Preh. Man in Cheshire,' 1911, p. 66, fig. 30	Warrington Mus.	Found under a bog near the Dog and Dart Inn.

Site of discovery.	References.	Present abode.	Remarks.
Cornwall—			
Boconnoc	P.S.A., 2 S. 5, 424	Bodmin Mus.	
Harlyn, pa. of Merryn, near Padstow	*Arch. Jour.*, **22**, 1865, pp. 275–277 ; Evans, p. 42	Truro ,,	4⅜ ins. ; cutting edge, 2½ ins. Found with two gold lunulæ.
Derbyshire—			
Hartle or Harthill Moor	Bateman, 'Vestiges,' pp. 126–128 ; Evans, p. 42	Sheffield Mus. (J. 93,472, M. 4)	7½ ins.
Parwich Moor, Shuttlestone	J.B.A.A., 7, 1850, pp. 210–220 ; *Arch.*, 43, p. 445 ; Bateman, 'Diggings,' p. 34	Ditto (J. 93,473, M. 29)	5½ ins. Found with bronze dagger with two rivets by side of a skeleton in a barrow.
Burntwood, Beeley		Ditto (J. 93,474, M. 109)	5¼ ins.
Oaker Hill, Darley Dale		Ditto (J. 93,475, M. 13)	4⅝ ins. Lower part only left.
Mill Field, Youlgreave		Ditto (J. 93,476, M. 58)	5 ins.
Moot Low, near Dove Dale	Bateman, 'Vestiges,' p. 68 ; 'Cat.,' p. 75, No. 18 ; Evans, p. 44	Ditto (J. 93,477, M. 18)	Found in a barrow with contracted skeleton.
Borther Low, near Middleton	Bateman, 'Vestiges,' p. 48 ; Evans, p. 48	Ditto (J. 93,479, M. 11)	1⅝ ins. Part only. Found in a barrow with skeleton, burnt flint arrowhead, pair of teeth of dog or fox.
Blakelow, Ashover	*Arch.*, 9, p. 85		Found with a flint "spearhead."
Devonshire—			
Near Sidmouth	*Trans. Dev. Ass.*, vol. 5, p. 82		4½ ins. Ornamented.
Dorsetshire—			
Preston Down, Weymouth	Evans, p. 46, fig. 5	Evans Collection	Sides slightly beaten up. Sage-green morocco patina.
Muddox Barrow, near Bere Regis		Dorchester Mus. (Br. 3)	
Jordan Hill		Ditto (Br. 2, Warne)	
Smallmouth, Weymouth		Ditto	Fragment of haft, said to be "from a midden."
Durham—			
Durham	*Journ. Anthr. Inst.*, 36, 1906, p. 23	Brit. Mus.	Found whan sinking a well. Copper.
Gloucestershire—			
Whittington	P.S.A., 2 S., 1, 1860, p. 235 ; Evans, p. 45	Society of Ants., Burlington House	5½ ins. Ornamented. (? flanged).
Hampshire—			
Herriard		Reading Mus. (A.L. XLVII.)	Apparently the lower part only, which has broken off and been used again.
Sholing	*H.F.C. Proc.*, 4, 1905, p. 78, pl. 2	Collection of Mr. W. Dale, Southampton	Ornamented.
Aldershot	Information kindly given by Canon Greenwell, Nov. 9, 1911.	In possession of Canon Greenwell	3 ins. Width of cutting edge, 1⅛ ins. ; width of butt end, ½ in.
Huntingdonshire—			
Yaxley Fen	Evans, p. 43. *J.A.I.*, 36, 29	Brit. Mus.	*Not* Taxley Fen. 8 % of tin.
Kent—			
Aylesford	P.S.A., 17, 1899, pp. 376–7, fig.		Found with two knife-daggers and a skeleton. The blades are both riveted ; one is flat and the other has a thick midrib.

Site of discovery.	References.	Present abode.	Remarks.
Lancashire—			
Gleaston Castle, Lower Furness	*Archæologia*, 5, pl. 7, fig. 1, p. 106		9 ins. × 5 ins. 2 lbs. 5 ozs.
Risdon, Warrington	L.C.A.S., 13, p. 126; *Arch. Jour.*, 18, p. 159; V.C.H., Lancs., 1, 1906, pl. 4, fig. 1; Evans, p. 46	Warrington Mus.	
Risley, near Warrington	P.S.A., 2 S., 5, p. 423 (called Risby)	Warrington Mus.	
Read	Evans, p. 47, fig. 6; Whitaker, 'Hist. of the Original Pa. of Whalley,' 3rd edit., 1818, pl. 2	Brit. Mus.	Sides slightly beaten up; found with two others.
Leicestershire—			
Beacon Hill, Charnwood Forest	P.S.A., 2 S., 1, 1859, p. 44; Evans, p. 43; Potter, 'Hist. and Ants. of C.F.,' p. 50	Soc. of Ants., Burlington House	"Ploughed up on the north-west side of Beacon Hill.
Northamptonshire			
Kettering		Brit. Mus.	
Northumberland—			
Newbiggin, Woodhorn	Evans, p. 43	Brit. Mus.	Two found together, about 1869, with two or three others, just outside the entrance to the churchyard at Newbiggin (information kindly given by Canon Greenwell, March 12, 1912).
Wallsend	Ditto	Ditto	
Alnwick	Ditto	Ditto	
Stamfordham		Ditto	
Ryall		Ditto	
Shropshire—			
Corvedale, Wenlock		Oxford, P.R.	
North side of Titterston Clee Hill	V.C.H., 'Shropshire,' 1, 1908, p. 203	Shrewsbury Mus.	Ham type.
Somerset—			
Staple Fitzpaine	V.C.H., 'Somerset,' 1, 1906, p. 188	Taunton Mus.	
Staffordshire—			
St. Bertram's Well, Ham	Evans, p. 42; Plot, 'Hist. of Staffs.,' p. 403, Tab. xxiii.	Oxford A.	
Suffolk—			
Exning		Brit. Mus.	
Eriswell, Mildenhall	Evans, p. 46	Evans Collection	6 ins. "Prigg Collection."
Icklingham		Ditto	Two. "Site of British Village."
Holywell Row, Mildenhall		Ditto	2½ ins.
Surrey—			
Albury	V.C.H., 'Surrey,' 1, 1902, p. 243		
Godalming	Ditto		
Sussex—			
Sedlescombe		In private hands	
*Pevensey		Lewes Mus.	Said to be "one of five" found there.
St. John's Common, near Clayton		Ditto	Lower part only.
Selsey		Worthing Mus.	

Site of discovery.	References.	Present abode.	Remarks.
Wiltshire—			
Long Barrow, near Stonehenge	*Wilts. Arch. Mag.*, 37, 1911, p. 130; *Arch.*, 5, p. 115, pl. 8, fig. 14; Evans, p. 47.		The original drawing is in Gough's volume of *Arch.*, 5, in the Bodleian (Gough, 'Gen.Top.,' 26). The celt is ornamented with vertical groove-markings arranged in a chevron pattern.
Wilsford	Hoare, 'Anc. Wilts.,' 1, 1812, p. 203, pl. 26; Evans, pp. 44, 51; *Arch.*, 43, p. 444, fig. 147; *Wilts. Arch. Mag.*, 37, 1911, p. 130.	Devizes Mus.	6⅜ ins., cutting edge 2⅝ ins. Edges *very* slightly beaten up. Belongs in shape to Arreton Period. Found in Bush Barrow, Normanton Group No. 158.
Near Tan Hill	*Wilts. Arch. Mag.*, 37, 1911, p. 129, pl. 6, fig. 2.	Salisbury (Blackmore Mus.)	-3¼ ins., cutting edge 1⅞.
Worcestershire—			
Bevere Island	'Allies,' p. 151, pl. 4, 11; Evans, p. 42.		4½ ins.
Cropthorne, Evesham		Brit. Mus.	Ornamented. Entered in B.M. register as "'Copthorne, Worcs.,' perhaps for 'Copthorne, Shropshire.'" The former county is more probable. The "r" has probably been left out in error.
Yorkshire, E. R.—			
Butterwick	Evans, p. 41, fig. 2; Greenwell, Br. 'Bars,' p. 188, fig. 38; P.S.A., 2 S. 5, 1873, p. 426. *J.A.I.*, 36, 1906, p. 24.	Brit. Mus.	*Analysis* Copper ... 87·97 Tin ... 10·74 Lead ... Trace Iron ... 0·10 Nickel ... 0·06 Arsenic ... 0·56 Antimony ... 0·15 Silver ... 0·16 Found with three-riveted knife-dagger of Honington type, and bronze awl, with male skeleton.
Knapton	Evans, p. 43	Ditto	
Langton Wold		Ditto	"Waisted" and ornamented.
Barrow on Wold Farm, Willerby.	*Arch.*, 52, 1890, p. 3	Ditto	Hoard of four, older than the barrow, in which was a skeleton with a beaker.
Sherburn Carr	Evans, p. 43	Ditto	5⅝ ins., found with one other nearly similar, in the Evans Collection.
Raisthorp, Fimber	Evans, p. 43	Mortimer Mus., Driffield	
Leppington	V.C.H. Yorks., 1, 1907, p. 411	Ditto	
Yorkshire, N. R.—			
Lockton, Pickering		Brit. Mus.	*Not* Sockton.
Near Scarborough		Sheffield Mus. (J. 93,478, M. 22)	Found on moors, "very rude workmanship and much corroded."
York	V.C.H. Yorks., 1, 1907, p. 376	York Mus.	
River Thames—			
Near Tower of London		Brit. Mus.	

Site of discovery.	References.	Present abode.	Remarks.
River Thames (ctd).			
Near Hammersmith Bridge		Brit. Mus.	
Kingston		Ditto	Ornamented.
Site unidentified—			
*Chapel Fields, St. Margaret's	*Journ. Anthr. Inst.*, 36, 1906, p. 23	Ditto	Not St. Margaret's, Kent. Copper.
Isle of Man—			
East Surby, Rushen	First Report of the Arch. Comm., I. of M., pl. 4, 2; Evans, p. 44		
Hango Hill, Castletown	Evans, p. 43	Mr. Wallace of Whitehaven.	6½ ins.

2. WALES.

Cardiganshire—			
Farm of Rhydtortuchaf, Llansantfraed		Dolnacothy, Llanwrda, Carmarthenshire	
Glamorganshire—			
Pont Caradog, Brithder	Evans, p. 45	One in Evans Collection; three in Greenwell Collection, Brit. Mus.	6¼ ins. Found in making the Rhymney Railway.
Swansea	Evans, p. 43	Evans Collection	4¼ ins. 1872.
Merionethshire—			
Rhydd y Glafais Cynwyd		Chester Mus.	
Penrhyn Deudraeth		Brit. Mus.	
Monmouthshire—			
Newport		Evans Collection	Two found. From Edkins Collection, 1864.
Pembrokeshire—			
Llanfyrnach Common	*Arch. Camb.*, 5 S. 10, 1893, pp. 144–147		

3. SCOTLAND.

Aberdeenshire—			
Old Rain Fyvie		Farnham Mus.	
Glack Daviot	'Cat. of the Nat. Mus. of Ant. of Scotland,' Edinburgh, 1892	Ditto Edinburgh Mus.	 5 1/16 ins.
Aboyne	Ditto	Ditto	4 ins.
Kintore	Ditto	Ditto	5 ins.
Tarland	Evans, p. 57	Ditto	5¼ ins. Slight flanges?
Potarch, Birse		Evans Collection	Found 1861.
Argyllshire—			
Loch Fada, Colonsay	'Cat. of the Nat. Mus. of Ant. of Scotland,' Edinburgh, 1892	Edinburgh Mus.	4 ins.
Ayrshire—			
Fairlie Bog	J. Smith, 'Prehistoric Man in Ayrshire,' p. 60, fig. 139. (London, 1895)		6⅜ ins.
Auchendrane	*Ibid.*, p. 181		4⅞ ins.; cutting edge, 1⅞ ins. Slight flanges and trace of stop ridge.
The Maidens, Culzean Castle	P.S.A.S., 17, 1882–3, pp. 433–438. R. Munro, 'Prehistoric Scotland,' pp. 77–8, figs. 20, 82: Ayr and Wigton Collections, 4. 1884, pp. 1–8	In possession of the Marquis of Ailsa	Hoard of five, with one penannular ring. The largest of the Sholing type.

Site of discovery.	References.	Present abode.	Remarks.
Ayrshire (contd.)—			
Largs			5 ins.; cutting edge, $1\frac{7}{8}$ ins. Like the axe from Auchendrane.
Bog Farm, Kilwinning	Ayr and Wigton Collections, 4, 1884, p. 48, fig. 1	In possession of Mr. Hugh Ramsay in 1884	$6\frac{3}{8}$ ins. × $3\frac{1}{2}$ in. Ornamented with vertical chevron pattern.
Banffshire—			
Farm of Colleonard, Banff	*Gent.'s Mag.*, 1857, pt. i., pp. 487, 488; 'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892, pp. 126, 163; Evans, p. 56; P.S.A.S., 3, p. 245	Edinburgh Mus.	Hoard of seven, $5\frac{1}{2}$, 6, $5\frac{1}{4}$, $3\frac{1}{4}$, 6, the other two imperfect. Three ornamented. Said to have been found in a pot. (Ed. Mus. No. EA. 18, Cat., p. 163.)
Hill of Fortrie, Balnoon, Inverkeithny	'Cat. of the Nat. Mus. of Ant. of Scotland,' Edinburgh, 1892.	Ditto	Hoard of seven.
Dumfriesshire—			
Drumlanrig	Evans, p. 55, fig. 19	Evans Collection	
East Lothian—			
Waughton	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892	Edinburgh Mus.	$6\frac{1}{2}$ ins.
Camptown	Ditto	Ditto	$5\frac{3}{4}$, $4\frac{3}{4}$ ins. Two, not said to have been found together.
Edinburgh—			
Ravelston, near Edinburgh	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, p. 56	Ditto	7 ins.
Lawhead, Pentland hills	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, p. 57	Ditto	$13\frac{3}{8}$ ins. Weighs 5 lbs. 7 ozs. (John Cowan, 1867).
Cobbinshaw, Midcalder	Evans, p. 56	Evans collection	$4\frac{3}{4}$ ins.
Elginshire—			
Dyke		Brit. Mus.	
Lhanbryde		Ditto	
Sluie, Edenkillie	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, p. 270; Wilson, 'Preh. Annals,' I (1863), p. 381, fig. 55; *Proc. Soc. Ant. Scotl.*, 4, p. 187	Edinburgh Mus.	6 ins. Said to have traces of tin coating. Found with (?) one other and a halberd (11 ins. × $3\frac{1}{2}$ ins.), with four rivet-holes.
Forres	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892	Ditto	6 ins.
Fifeshire—			
Falkland	Evans, p. 59, fig. 22	Evans Collection	Two (not known to be associated), $6\frac{3}{4}$ ins.; 5 ins.
Dunino	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, p. 57	Edinburgh Mus.	$4\frac{1}{2}$ ins. Slight flanges?
Forfarshire—			
Forfar		Brit. Mus.	
Ditto	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892	Edinburgh Mus.	$5\frac{1}{4}$ ins.
Inverness-shire—			
Dores	Ditto	Ditto	$5\frac{7}{16}$ ins.
*Ardgour House	Ditto; P.S.A.S., 9, 182; Evans, p. 56	Ditto	$5\frac{3}{4}$ ins. × $3\frac{1}{2}$ ins. Found in a cave with bones of animals.
Kincardineshire—			
Dunnottar	'Scottish Exhibition,' 1911; 'Palace of History, Cat. of Exhibits,' 2, p. 853	Montrose Mus.	$5\frac{3}{8}$ ins. × $3\frac{1}{16}$ ins. Found in 1848.
Lanarkshire—			
Biggar	Evans, p. 55	Ditto	$6\frac{1}{4}$ ins.
Coulter	ditto	Ditto	$5\frac{1}{4}$ ins.

Site of discovery.	References.	Present abode.	Remarks.
Midlothian—			
Northplot hill, near Ratho	Evans, p. 55.	Montrose Mus.	6 ins. Slight flanges?
Mountskip, Vogrie	Evans, p. 57	Ditto	Ditto.
Nairn—			
Near Nairn	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, pp. 58-9, fig. 21	Ditto	10½ ins. Ornamented "with four rows of punch-marks arranged in a chevron-like pattern, parallel to the edges."
Near Nairn		Brit. Mus.	
Perthshire—			
Abernethy	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, p. 56	Edinburgh Mus.	
Pitlochrie	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892.	Ditto	4¾ ins. Copper.
Renfrewshire—			
Durris, Mearns	Ditto	Ditto	5¾ ins.
Kilmalcolm		Brit. Mus.	
Roxburghshire—			
Eildon	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892; Evans, p. 57	Edinburgh Mus.	7 ins. Found "with spear-head (D.G. 41) under a large cairn." This statement is considered very questionable by Dr. Anderson.
Ashybank	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892	Ditto	6¾ ins. Site and circumstances of discovery unknown.
Melrose	'Scottish Exhibition,' 1911, 'Palace of History, Cat. of Exhibits,' 2, p. 853	"Lent [to exhibition] by Tom Scott"	5 ins. × 2½ ins. Found in 1865.
Selkirk—			
Greenhill	Ditto	Ditto	4⅝ ins. × 2½ ins.
Sutherlandshire—			
West end of Loch Migdale, in pa. of Criech, on Skibo Estate	P.S.A.S., 35, pp. 266–275		Two flat celts, conical jet buttons, etc., etc. A very important hoard.
Inchnadamff	'Cat. of the Nat. Mus. of Ant. of Scotland,' 1892: Evans, p. 57	Edinburgh Mus.	6 ins. Slight flanges?
Wigtonshire—			
Cree Moss, Wigtown Bay	Ditto; 'Wilson, Preh. Annals, 1, 1863, p. 381, fig. 53; 'Ayr and Wigton Collections,' 2, 1880, p. 6, fig. 1; Evans, p. 56	Ditto	5 ins.
Barrachan, Mochrum	Ditto	Ditto	6 ins.
Kevens, Whithorn	Ditto	Ditto	4¾ ins. Kevands on O.S. map.
Innermessan, Inch	Evans, p. 56; 'Ayr and Wigton Collections,' 2, p. 7, fig. 2	In possession of the Earl of Stair	6⅜ ins. × 3⅝ ins.
Knock and Maize Farm, Leswalt	Evans, p. 56; notes	Ditto	5¼ ins. × 3 ins.
Drumdoch, Inch	'Scottish Exhibition, 1911'; 'Palace of History, Cat. of Exhibits,' 2, p. 853	L. M'L. Mann Collection	5½ ins. × 3⅛ ins.

Site of discovery.	References.	Present abode.	Remarks.
Wigtonshire (cont.)			
Boreland, Inch	'Scottish Exhibition, 1911'; 'Palace of History, Cat. of Exhibits,' 2, p. 853	In possession of the Earl of Stair.	6⅝ ins. × 4⅞ ins.; 7 ins. × 5⅛ ins. Two, probably found together.
County not ascertained—			
*Braemoray		Brit. Mus.	? Near Elgin.
	4. IRELAND.		
Antrim—			
*Craigbilly		Dublin Mus.	Copper.
Connor		Brit. Mus.	Three.
Ballymena	J.R.S.A.I., 31, 1901, pp. 265–279, figs. 52–57		Copper.
Portnashoal, Lower Bann	Wilde, p. 432	Dublin Mus.	5½ ins. × 3 ins. Copper.
Dunluce Castle		Lewes Mus.	? Found at Dunluce.
R. Bann, Cutts, Coleraine	*Ibid.*, p. 396	Dublin (Shelf 1, Tray A, No. 4)	Copper.
*Near Ballymoney		Oxford P.R.	Hole in top of haft. ? which Ballymoney
Near Clough Mills		Evans Collection	
Near Rasharkin		Ditto	
Near Armoy		Ditto	
Near Bushmills		Ditto	
Carlow—			
Slyguff, Bagnalstown		Dublin Mus.	
Cavan—			
Tuberline, Templeport		Ditto [23, 1909]	Copper.
Croghan		Brit. Mus.	
Clare—			
Bed of Scariff river	Wilde, p. 403	Dublin Mus.	3 ins. × 1½ ins.
Cork—			
Kilcrea Castle	Wilde, p. 364	Ditto	Very large, 12¼ ins. × 8½ ins.; 4 lbs. 14 ozs.
Mallow		Brit. Mus.	Large.
Bandon		Ditto	Edges beaten up.
Castletown Roche		Oxford, A.	Old label says, "Only four found, all of which are in this collection" (name of owner of collection indecipherable: initials W. C. Only two out of the four are in the Ashmolean, and were obtained by Fortnum long before 1885, and presented by him to the Ashmolean).
Ballybeg	J.R.S.A.I., 31, 1901, pp. 265–279, figs. 52–57		Copper.
Dunmanway	Ditto		Ditto
Mallow		Oxford, P.R. (1425, 2327)	
Ballybawn, near Ballydehob	Evans, p. 61	Evans Collection	"Copper, R. Day, junr." ? Ballybane (O.S. one-inch map, Sheet 199).
Donegal—			
Letterkenny		Dublin Mus. (114, 1897)	Copper.
Ditto		Ditto	
Down—			
Dromore, co. Down	Information kindly given by Canon Greenwell, Nov. 6, 1911	Brit. Mus., 1526 (1863)	Found 1863. Greenwell Collection.

Site of discovery.	References.	Present abode.	Remarks.
Dublin—			
Suffolk street, Dublin		Dublin Mus.	Two, of copper.
Clontarf		Salisbury (Blackmore Mus.)	5½ ins. × 3 ins.
Fermanagh—			
Ballinamallard	Evans, p. 61, fig. 27	Evans Collection	? Copper.
Galway—			
Loughrea		Salisbury (Blackmore Mus.)	
Four feet below bed of Clare river, Lehid, Dunmore	Wilde, p. 403	Dublin Mus.	4¼ ins. × 2 ins.
Bog at Knockague, Kilbennon, near Tuam	J.R.S.A.I., **31**, 1901, pp. 265–279, pl., figs. 44–48	Ditto	Three flat celts, three awls, one knife (pointed and tanged). All of pure copper. Found in 1874.
Kerry—			
Clontoo, Kenmare		Ditto (5. 6. 1906)	Two of copper
Ardfert		Brit. Mus.	
Killarney		Oxford, P.R. (1434)	
Bed of the Carrhan river, Baronry of Iveragh	Wilde, p. 399	Dublin Mus.	4¾ ins. × 3½ ins. "Triangular" type, found with another (6 ins. × 3¾ ins.)
Beaufort, Killarney	J.R.S.A.I., **31**, 1901, pp. 265–279	Brit. Mus.	With three others, of copper, in the Dublin Museum.
Kildare—			
*Newington	Wilde, p. 401	Dublin Mus.	4½ ins. × 2¾ ins.
Kilkenny—			
Gowran		Brit. Mus.	? Copper.
Jerpoint	J.R.A.I., **31**, 1901, pp. 265–279, figs. 52–57		Copper.
King's Co.			
Birr	Ditto		Three copper celts, fragment of a fourth, copper halberd, short blade of copper.
Bog of Cullane, near Killyon		Oxford, P.R.	
Derrinsallow	'Horæ Ferales,' pl. iv., Fig. 2	Brit. Mus.	6½ ins. Found in 1852.
Leitrim—			
Drumshambo		Dublin Mus.	
Bed of Ballyheedy river, below Ballinamore, townland of Ardrum, pa. of Oughteragh	Wilde, p. 406	Ditto	5⅝ ins. × 3⅛ ins.
Londonderry—			
Near Londonderry		Evans Collection	
Longford—			
Ardach		British Mus.	
Ballymacormick		Ditto	
Louth—			
River Boyne, Drogheda		Salisbury (Blackmore Mus.)	
Greenmount, Castle Bellingham	Evans, p. 63; *Arch. Jour.*, **27**, p. 308		
Mayo—			
Killala	Wilde, p. 396	Dublin Mus.	Copper.

Site of discovery.	References.	Present abode.	Remarks.
Meath—			
Tara	'Horæ Ferales,' pl. iv., fig. 7	Brit. Mus.	
Athboy		Ditto	
Kells		Ditto	
Queen's Co.			
Stradbally		Ditto	
Roscommon—			
Boyle		Ditto	
*Toomina	Information kindly given by Canon Greenwell, Nov. 9, 1911	In possession of Canon Greenwell	5¾ ins.; width of cutting edge, 3½ ins.; width of butt end, 1 in. Ornamented.
Tipperary—			
Rock of Cashel		Farnham Mus.	
Ditto		Ditto	
Dundrum		Dublin (R. 133, 1881)	Copper.
Tyrone—			
Five mile town		Brit. Mus.	
Ditto		Ditto	
Cloghfinbar mountain, Donaghmore		Ditto	
Mountfield		Dublin Mus. (112, 1897)	Copper.
Trillick		Evans Collection	
West Meath—		Brit. Mus.	
Athlone (near)			
Ballinderry House, near Moate, Meath	Munro, 'Lake-dwellings' (1890), p. 359	Brit. Mus.	
River Shannon—			
*Cornacarrow	Wilde, p. 398	Dublin Mus.	7¼ ins. × 5½ ins.
Keelogue Ford, between the counties of Galway and Tipperary	Ditto	Ditto	6⅛ ins. × 5 ins. (cutting edge).

STONE MOULDS FOR FLAT CELTS.

England.

Durham—			
Hurbuck, Lanchester	P.S.A.S., 38, 1903–4, pp. 492–3 (J. G. Callander)	Brit. Mus.	Two from same district, one of Mr. E. W. E. Balleny, Consett.
Northumberland—			
Cambo, Wallington	Ditto	Ditto	

Scotland.

Aberdeenshire—			
Pitdoulzie, Auchterless	P.S.A.S., 40, p. 35		
Kintore	P.S.A.S., 38, 1903–4, pp. 492–3		
Foudland, Insch	Ditto		
New Deer	Ditto	Collection of Mr. Alex. Gray, New Deer	
Banffshire			
Marnoch	Ditto	Banff Mus.	
Nairn			
Culbin Sands	Ditto		Two moulds.

Site of discovery.	References.	Present abode.	Remarks.
Ross-shire—			
Strathconan	P.S.A.S., 38, 1903–4, pp. 492–3	In possession of the Rt. Hon. A. J. Balfour, Whittinge-hame	
	IRELAND.		
Antrim—			
Carrickfergus	P.S.A.S., 38, 1903–4, pp. 492–3	Bateman Collection	
Ballymena	Ditto; Evans, p. 428, fig. 515	Evans Collection	
*Loughcall		Farnham Mus.	
Down—			
Ballynahinch	Wilde, p. 392, fig. 307; *Arch. Jour.*, **4**, p. 327	Belfast Mus.	Mould for four flat celts, largest 6 in. × 4½ ins.
Leitrim—			
Lough Scur Crannog	Wilde, p. 91, fig. 72; P.S.A.S., 38, 1903–4, pp. 492–3	Dublin Mus., No. 83	Mould for a flat celt and for a flanged celt with loop and stop-ridge.
Site unknown	P.S.A.S., 38, 1903–4, 492–3	Edinburgh Mus.	Mould for three flat celts and one flat knife.
,,	Ditto	Belfast Mus.	

HYDROGRAPHICAL SURVEYS OF THE ADMIRALTY DURING THE YEAR 1911.

THE report on the Admiralty Surveys for the year 1911 has recently been issued by the Hydrographer, and from this it is clear that apart from the usual work carried on round the coasts of the British Isles and elsewhere in connection with the sounding and resurveying of harbours, river entrances, banks and channels, which is continually in progress, a considerable amount of important work has been done abroad in surveying coast-lines that have never been accurately charted before, or only laid down approximately. Off the north coast of Australia a resurvey of Goode island anchorage was made by the *Fantôme* (Lieut. J. D. Nares) in May, and a search for reported dangers along the north coast undertaken. In June the survey of the Buccaneer Archipelago, on the north-west coast of Australia, was commenced by the same ship and continued till November. From June to December a survey of the north-west coast of Borneo was in progress by the *Merlin* (Commander B. O. M. Davy) between Labuan island and Barram point. On the west coast of Africa the *Mutine* (Capt. E. C. Hardy) was at work in the early part of the year surveying the Liberian coast northward from Settra Kree, and on the Gold Coast, where a survey of Axim anchorage was successfully carried out. After doing useful work on the coast of Natal the ship again returned to Liberia to carry on the surveys which had been commenced earlier in the year, and which were unavoidably postponed. The *Sealark* (Commander R. W. Glennie) has been busily engaged in the Solomon islands charting the south coast of Florida island and the inner route to Torres strait. The *Waterwitch* (Commander R. L. Hancock), during her stay in Hongkong, sounded the Kaulung coaling camber and made a plan of Quarry bay, and while on her passage from Hongkong to Singapore a line of soundings was run between latitudes 15° N. and 8° N. Later on a survey of the

eastern approach to Singapore was commenced, and a portion of the western approach charted.

This is some of the more important work carried out during the past year by the surveying vessels of the Admiralty in foreign ports, but the Hydrographer's report gives an interesting detailed account, and mentions also the valuable work done by the Indian Marine Survey in correcting the charts of the coast of India.

At the end of the report is a list of the miscellaneous documents forwarded to the Hydrographical Department during the year, and which have been more or less useful in correcting the Admiralty charts. Among these it is interesting to note the recent survey of the coast of Labrador by Sir William Macgregor and Dr. Grenfell.

The new charts published by the Admiralty have been given as they appeared in the monthly list of the *Geographical Journal*.

In conclusion, it may be mentioned that during the year 1911 as many as 442 rocks and shoals dangerous to navigation were reported. Of these 13 were discovered by vessels striking on them, 108 were reported by surveying ships, 8 by other of H.M. ships, 10 by various British and Foreign authorities, and 303 by Colonial and Foreign governments; while in the same period 36 previously reported dangers have been expunged from the charts.

Altogether a length of 906 miles of coast-line has been charted, and an area of 5405 square miles sounded over, while the Indian Marine Survey charted 212 miles of coast-line, and sounded over an area of 2819 square miles.

THE EIGHTEENTH INTERNATIONAL CONGRESS OF AMERICANISTS.

THIS congress, held at the University of London, May 27—June 1, under the presidency of Sir Clements R. Markham, K.C.B., F.R.S., was attended by 150 foreign members, most of whom possess valuable information respecting little-known parts of the Americas. Geography has not hitherto been treated at these meetings (which are fully occupied in considering the history, ethnology, religion, and linguistics), and opportunities are thus doubtless lost of consulting men who have local knowledge, and could correct maps or give definite information. Some of the papers contributed were of geographical interest. Waldemar Jochelson, of St. Petersburg, described the work of the ethnological section of the Riabushinsky Expedition, sent under the auspices of the Imperial Russian Geographical Society, in 1908, to the Aleutian islands and Kamchatka. His party were occupied in field work there for three years, and studied the folklore of the Aleuts, their physical type, and the language, which is of Eskimo orgin. Thirteen ancient village sites and some huge shell-heaps were excavated, and implements, weapons, ornaments, and other prehistoric objects of stone and bone were found in them. In Kamchatka, in the old underground dwellings and fortifications, the existence of pottery (which had been denied by former travellers) was ascertained. The mythology of the Kamchadal proved to be identical with that of North-West America, and there is a morphological relation between the language and those of some American Indians.

Mr. J. A. Mason, a Fellow of the International School of American Archæology and Ethnology in the city of Mexico, spent four months last winter amongst the Tepecano or Tepehuán at their village Azqueltán in the great barranca of the Rio de Bolaños, which borders the states of Zacatecas and Jalisco, in order to study the remnant—less than one hundred of sufficiently pure blood—of this people, who

claim to be descended from the more ancient inhabitants. Their religion is closely related to that of the Huichol and Cora, and the ceremonial feasts and preparation of symbolic objects form a prominent part in their lives. Formerly, "from Arizona to Jalisco, a stretch of 1000 miles along the ranges of the Sierra Madre, there lived peoples speaking the closely connected Pima and Tepehuán languages. Together with these are found other languages, such as Tarahumare, Yaqui, and Opata, undoubtedly connected, but probably differing considerably. There are great ethnological differences between such extremes as the Pima in Arizona and the Tepehuán of Azqueltán." Careful work amongst the many isolated communities who still possess remains of the ancient cultures, customs, and traditions is of the highest value, and the school in Mexico will undertake this if well supported.

Jonkheer L. van Panhuys gave an account of the Sixth "Surinam" Expedition sent to explore the interior of Dutch Guiana, in the autumn of 1909, up the Surinam river. Near the source of one of its branches, the Gran Rio, the head of a stream leading to an unknown region was discovered. This proved to be an affluent of the Corentin, and was followed down by the seventh expedition. The Government also sent a commission to make a scientific inquiry on the malarial fever in the interior. This appears to be African malaria imported by the bush-negroes (and *Anopheles albipes*) when they were brought from Africa, and the infection then communicated to the Indians.

Dr. K. T. Stoepel was asked by the Berlin Museum of Ethnology, in 1911, to investigate the ancient remains at San Agustin, on the upper waters of the Magdalena in Colombia, which had never been systematically studied. They were first described in 1857 by General Codazzi, the silence of previous Spanish chroniclers being probably due to the fact that the monuments had long been hidden by vegetation. Massive stone coffins over 6 feet long, in vaults of almost modern type covered by artificial mounds, gigantic statues, and a remarkable chamber with sculptured stone door-jambs, have been discovered, and further search will doubtless be fruitful of results. Dr. Stoepel brought away eighteen paper moulds, and many photographs and drawings.

Five papers dealt with as many tribes of central and southern Brazil. Dr. E. Roquette Pinto gave the results of an official expedition under Colonel Rondon in the state of Matto Grosso, where he was able to enter into friendly relations with the Nhambiquára, of whom little was hitherto known. They are divided into two groups, Uái-koá-korê and Ouihanierê, the latter being darker skinned and more warlike. They are of medium height, live by the chase, and also plant millet, yams, mandioco, potatoes, and beans. Their bows vary from 1·80 metres to 2·38 metres in length, and to draw an arrow 50 cms. long with the larger bow, a traction force of 60 kilos. is needed, as proved by the dynamometer.

Herr A. Frič, of Prag, has spent several years among the Chamakoko and Kaduveo, has learned the rites of initiation into their brotherhoods and studied their mythology. His paper compared them and the Kaingan with the Bakairi, and he contributed many feather ornaments, wooden fetishes, and other objects from his collections to the exhibition held during the congress. The Kaingan tonsure their heads, which is also a custom of the Cherentes. Prof. J. Feliciano had opportunities of conversing with chiefs of the Cherentes from 1906 to 1911, and has brought together much new information. They were only grouped into villages in the middle of the last century, and till then had retained their own customs and original language.

The extinct tribe of the Goia was the subject of a memoir by Captain H. Silva. They are described by early writers as smaller and of paler colour than their neighbours, and, according to P. Christoval de Acuña, were "dwarfs no larger than

children of tender years." In 1682 the first civilized settlement was made in one of their villages by the Paulist Fathers, who gradually acquired all their lands and forced them to work in the gold-mines. Not being accustomed to hard labour, their numbers rapidly decreased. Herr F. Mayntzhusen sent an interesting account of the "Birth and Naming Customs of the Guayaki" of Alto Paraná, whom he has been the first to observe. They were wild and shy, accustomed to flee from strangers until he tamed them by kindness.

A. C. B.

REVIEWS.

EUROPE.

A Study in Physical Geography.

'Le Jura Méridional.' By the Abbé J. B. Martin. Pp. 1-219. Paris: Librairie Ch. Delagrave. 1910. 7 *fr.* 50.

The Jura mountains have long been quoted in text-books of structural geography as affording typical examples of simple symmetrical flexures. The Abbé Martin, however, in this instructive volume emphasizes the complexity of their intimate structure, and by quoting the diverse opinions of well-known writers, draws attention to the peculiar nature of the difficulties which confront the scientific geographer in any attempt to explain the origin of their present topography. While it is true that there are many well-marked synclinal valleys in the Southern Jura, frequent examples may also be found of the crossing of anticlinals by rivers and streams, and such occurrences, according to the author, are conditioned quite as often by the dipping or faulting of the anticlinal axes as by ordinary processes of capture. There are, however, two remarkable transverse valleys (*cluses*) crossing the Southern Jura from east to west, whose origin has given rise to much speculation. The summits of the anticlinals are also curiously flattened, a fact which has led Brückner to suggest that the Jura after the Miocene folding underwent peneplaining more than once. The author rejects this hypothesis as well as that of Machácek, who has suggested a slow progressive zonal elevation of the Jura from north-west to south-east, extending over the whole period from the Miocene to the present. The abbé elaborates an hypothesis of his own whose main feature is the recurrence of movement and the accentuation of the earlier folds at various later periods (*soulèvement par saccades*). According to him the Rhone at one time crossed the Jura by way of the *cluse* Culoz-Ambérieu, while its present course was established in some obscure manner during the Ice Age, apparently with the help of contemporaneous crustal warping.

In the preface the author states that he has attempted to apply the methods of modern geography to the interpretation of the present topography of the Southern Jura. One regrets to find, however, that in his work he gives encouragement to the idea that the details of the solid geology of a region form an integral part of its geography. A similar misconception indeed prevails amongst the writers of most modern textbooks of geography. It should be remembered, however, that geographers make no claim to be geologists, and that the wholesale importation into geographical works of the results and nomenclature of stratigraphical geology serves only to discredit the younger science. Another regrettable feature of the abbé's work is its poverty in maps. A geographical monograph should be equipped with an abundance of sketch maps upon which every locality mentioned in the text should be clearly marked.

Nothing renders a work of this kind more tedious to read—especially when, as here, the style is somewhat involved—than inability to follow the writer's descriptions and arguments with ease and intelligence, on account of the absence of suitable maps. Apart from these defects and the total absence of an index or even of a *table des matières*, the abbé's work may be recommended as showing an intelligent appreciation of the problems of geography and a praiseworthy attempt at the elucidation of the topography of a particularly difficult region.

J. D. F.

'Cracow, The Royal Capital of Ancient Poland.' By Leonard Lepszy. (London: Fisher Unwin. 1912. Pp. xv., 219. *Illustrations.* 10*s.* 6*d.*) This is a detailed description of the capital of Poland, excellently translated from the original of Dr. Lepszy. There are some very fine photographs of architectural details and general views.

'A Winter Holiday in Portugal.' By Captain Granville Baker. (London: Stanley Paul & Co. 1911. Pp. 324. *Illustrations.* 12*s.* 6*d. net.*) Captain Granville Baker's *impressions de voyage* are readable, entertaining and vividly described, but they do not add much to our geographical knowledge of Portugal or of its social conditions. The author has certainly an eye for the picturesque in history and never loses an opportunity of recounting stirring episodes in the story of Portugal. Indeed, Captain Baker seems a little obsessed by the undeniably attractive romantic associations of the country, and is inclined to ignore the stern facts of the present. We must not lose sight of a well-drawn map, for which the author has to thank the Sociedade Propaganda de Portugal. The high-roads and railways are very clearly delineated and the map is not overcrowded with names.

'Atlas de Finlande.' (Helsingfors: Société de Géographie de Finlande. 1910–1911. *Atlas and two volumes of text.*) In the present edition the Atlas of Finland has been brought up to date in every respect, and the standard of this monumental work is as high as in the first issue. It is unnecessary to recapitulate the extraordinary number of details which are illustrated by maps, dealing not only with the physical conditions of Finland and Finnish waters, but with every aspect of the administrative, economic, and ethnographical conditions of the country. The high degree of accuracy necessary to the close detail of some of the maps reflects the greatest credit on the printers. Perhaps the only maps which might have been more successfully executed are the town plans, in which, while no great amount of detail is attempted, at the same time no very clear idea of the geographical position of the towns is presented. But this atlas ought as a whole to be an example to the geographers of many lands, and especially to cartographers, for most of the work on the mechanical side could hardly be improved upon.

'The Making of London.' By Sir Laurence Gomme. (Oxford: Clarendon Press. 1912. Pp. 255. *Illustrations.* 3*s.* 6*d.*) The Clerk to the London County Council, than whose authority on the early history of London none stands higher, deals in his opening chapter with the evolution of the site of the city and traces its origin from prehistoric times, adducing such scanty evidence as has been found for the conditions under which the site was occupied in those times. He then carries the history of London through the ages up to the present, and the volume presents the main features of that history admirably in so short a compass, never ceasing to be readable. The illustrations also are of deep interest.

ASIA.

Levelling by The Indian Survey.

'Levelling of Precision in India.' Vol. 19 of 'Account of the Operations of the Great Trigonometrical Survey of India.' By Colonel S. G. Burrard, R.E., F.R.S. 1910. Ten rupees eight annas.

In the nineteenth volume of the account of the 'Operations of the Great Trigonometrical Survey of India,' Colonel Burrard discusses the precise levelling which has been carried out from 1858 until 1899. In so long a period improvements in instruments and in method have naturally taken place so that the whole mass of the material is not altogether homogeneous, but there is a very great advantage in having so long a period of high-grade work discussed as a whole. The levelling instruments which have been employed are described from the rectangular level of 1860, which is still in use, to the American binocular level which has recently been introduced. Levelling staves, too, have been modified of late in order to attain higher precision, and the results of comparisons of different staves with a 10-foot stand and bar at different dates are given. The experience gained during fifty years concerning the permanence and the reliability of different forms of benchmark, and the suitability of various sites, is most valuable, and will afford guidance in many colonial regions where high-grade levelling is needed, and where the conservance of benchmarks presents serious practical difficulties. The vicinity of railway lines is found to be unsuited for primary benchmarks and these should whenever practicable be on solid rock. In dealing with so large an area as the Indian peninsula it is necessary to take into consideration the fact that the Earth's figure is spheroidal, and that the intensity of gravity is greater at the equator than at the poles; consequently if we imagine an envelope of water to cover the Earth to the altitude, for example, of the Tibetan lakes, its surface will not be parallel to the mean surface of the sea, but the two surfaces will be at a maximum distance apart at the equator and will converge towards the poles. A large high-level lake, therefore, when level and undisturbed, will be at a greater height above the surface of the sea at its equatorial end than at its polar end. Thus we have two methods of expressing altitude, the orthometric height in which the actual vertical distance above sea-level is measured as in spirit-levelling, and the dynamic height derived from observation of water-flow. In the present volume both the dynamic and orthometric heights are given. The mean sea-level to which the levelling is referred is based upon observations made at nine open-coast tide-gauge stations, carefully selected from the forty-two stations at which series of observations had been made. So far as experience goes, after a careful study of the results obtained, the report states that no relative movement of land and sea has been detected between Karachi and Bombay where forty years ago it was believed that the coast was slowly subsiding beneath the sea. The third part of the volume contains a discussion of the levelling errors which will be of the highest interest to geodesists. Deducing from discrepancies between levellers that both accidental and systematic errors must be considered in any formula to represent the law governing the accumulation of error, and also after discussing the law of error deduced from the closing errors of circuits, the conclusion is arrived at that the formula expressing the relationship between the probable error in feet of Indian levelling and the distance levelled in miles is—

$$E = \sqrt{(0{\cdot}004)^2 M \times (0{\cdot}00034)^2 M^2)}$$

The whole volume bears witness to the minute and long-continued care and accuracy which is necessary in geodesy if those definite results which are of so great practical importance are to be reached. H. G. L.

Russian Exploration in the Altai.

The Mongolian Altai at the sources of the Irtish and Kobdo,' by Prof. W. W. Sapozhnikoff. Tomsk. 1911. 15*s.* 6*d.*

Russian exploration in the little-known parts of Asia does not always receive the attention due to it, owing chiefly to the language difficulty. There are, however, large areas of country, and very important geographical problems, which have only been dealt with by Russian scientists, and the literature of these regions, being seldom translated, is on this account hidden from us. The area in which Russia has had the monopoly of exploration lies along her Asiatic frontiers from Manchuria to the Caspian. Of this vast area there is none so little known to English scientists as the Siberian-Mongol frontier, especially in the region of the Altai ranges. The Alps of the Russian and Mongolian Altai have for a long time attracted the attention of travellers, and of these perhaps the veteran is Prof. Sapozhnikoff, who for fifteen years has laboured at his researches into the physical geography, botany, and zoology of these Alpine regions. Prof. Sapozhnikoff's work in the Altai region, extending over so many years, and backed up by his sound scientific knowledge, has qualified him for the task of publishing this book, which must remain for a long time the standard work on a highly interesting region.

Ever since 1881, Russian explorers have been "touching" on these somewhat remote ranges. They have passed along their southern flank and surveyed the northern slopes, but they have done so without going into great detail and without penetrating to the alpine regions. The survey of the Mongolian Altai was superficial until Prof. Sapozhnikoff set himself the task of its thorough exploration.

Until 1905, Prof. Sapozhnikoff's work lay in the Russian Altai; but between 1905–1909 he investigated the long chain which extends in a south-easterly direction, into Chinese territory, called by him the Mongolian Altai, but which, on our maps, has been so far misnamed the *Great Altai*.

The results of these journeys have now been published in book form at Tomsk, and we have a most complete description of the whole range from the Russian frontier to Kobdo. The volume consists of a detailed description of the author's whole itinerary, and a systematic account of the Mongolian Altai between the frontier and the sources of the Black Irtish, a distance of about 250 miles. This portion includes chapters on the orography, a complete account of the newly discovered glaciers, and a report on the hydrography of the region. Further, he deals with the comparative precipitation on the northern and southern slopes, respectively; and describes the botanical zones, whilst the fauna and the inhabitants are touched upon in a cursory fashion. The work is illustrated with three maps and numerous photographs.

The principal map, which is on a scale of 1 : 840,000 (or 13·26 miles to an inch) takes in the whole region from the Black Irtish to the western end of the upper Yenisei basin, and from the Russian frontier to Kobdo. It is based on existing astronomical points, augmented by the professor's own determinations of latitudes. On the Russian frontier his new work rests on the survey of Military Topographists of the Omsk Staff. His own original work is dependent upon theodolite and plane-table work, and his altitudes by aneroid and hysometer. Besides this large sheet, he gives us a most instructive map, on a scale of 1 : 210,000, of the peaks and glaciers of the culminating point of the range—the Tarbyn-bogdo-ola, which shows us in great detail the numerous glaciers and the position of the highest peaks. The whole of this is a valuable addition to our knowledge of an area hitherto absolutely unknown.

From this volume we get, for the first time, an excellent idea of the orography of the whole region. We now see the "Great" Altai reduced to a ridge, averaging 10,000 feet in height, which extends from the main mass—the group of Tarbyn-bogdo-ola—in a south-easterly direction for some 700 miles before disappearing in the Gobi. Excepting the Tarbyn-bogdo-ola, only one summit rises to a height of over 13,000 feet, namely, the isolated summit of Mustau, in the centre of the range (alt. 13,120 feet).

The Tarbyn-bogdo-ola, then, is the feature of the range, and here Sapozhnikoff spent much of his time, tracing the sources of the rivers, mapping the glaciers and determining the height of the peaks. On the slopes of this central mass are the sources of the Kobdo river, and the Kanas and Alasha tributaries of the Black Irtish. Here is a world of ice and snow extending over an area of 90 to 100 square miles. Of the "Five Holy Mountains," which compose the group, the culminating point is Mount Kiityne, which rises to 14,760 feet above sea-level. There is much of interest in Sapozhnikoff's report on the glaciers, which he discovered in these regions. At the sources of the Tsagangol branch of the Kobdo river he found ten glaciers, of which the most important he named after Potanin, the pioneer explorer in these regions; this glacier had a length of 12½ miles and a width of a mile and a half. At the sources of the Kanas river he found no less than twenty glaciers, some of which extended for 7 miles. But it should be noted that on the northern or Russian side, at the sources of the Alasha, there were only a few small glaciers. He also notes that the glaciers on the Mongolian Altai do not extend so far down as those on the Russian side. The Bielukha glacier comes down to 6560 feet above sea-level, whilst those of Tarbyn-bogdo-ola do not extend below about 8000 feet. He records the existence of old moraines, which proves the previous extension of glaciers 30–60 miles further than their present termination.

When describing the hydrography of the Black Irtish, Sapozhnikoff brings one remarkable fact to light, namely, that this river is navigable to a point a long way within Chinese territory. The problem of the possible underground connection between Ulungur lake and the Irtish is again discussed. And in spite of the assertion of Miroshnishenko, who, in 1873, proved that the flow of this river increased by some 89,000 cubic feet of water per minute below the lake, without the help of any tributaries, Sapozhnikoff refutes the supposition on the following grounds:—

(1) The Ulungur lake is *lower* in altitude than the river.

(2) The water is strongly saline (a peculiarity of enclosed basins).

(3) Neither in the lake nor in the river does one find certain species of fish peculiar to the Irtish.

Prof. Sapozhnikoff also gives some interesting data on the comparative precipitation of both slopes of the Altai. From his observations the Mongolian Altai differs from the other mountain ranges in Central Asia, in that the southern side and not the northern is the richer in vegetation. He explains this by the fact that the south-west slopes are longer and higher than those of the north-eastern side. And, as the currents of moisture all come from the west, these slopes relieve them of their moisture before they can reach the north-easterly side. As a result, the south-west is well clothed with vegetation, and forests extend along the range in a zone reaching from 3300 feet to 7800 feet. On the north side, however, there is little forest, and that only in the zone between 6500 feet and 7800 feet.

This fact decides the distribution of the nomadic peoples who use the mountain as a grazing ground, amongst whom a remarkable variety of tribes is to

be met with. The Kazak-Kirei are most predominant, and being a people about whom every detail is of interest, Prof. Sapozhnikoff's notes on them are of special value. Uriankhai, Oletes, Torguts, and Durbets are the other tribes of Mongol origin, inhabiting the slopes of the Altai.

At the end of the volume Prof. Sapozhnikoff, who is a botanist by profession, goes into great detail as regards the floristic zones, and adds a catalogue of 722 species of plants. There is a list of the fauna and a table of 407 hypsometric readings.

D. C.

'Baedeker's Palestine and Syria: with Routes through Mesopotamia.' By Karl Baedeker. (London: Fisher Unwin. 5th edit. 1912. Pp. 462. 14*s.*) In this new edition (remodelled and enlarged) of Baedeker's Palestine, next to Egypt and Switzerland perhaps the best of this well-known series, a carefully summarized description of Cyprus is a new and valuable feature. As the quasi-official handbook to Cyprus has been apparently discontinued, the inclusion of this island in the Palestine handbook is opportune. Full details are given of the recent changes in the conditions of travel. A special word of praise is due to the maps, no less than twelve being either new or completely re-drawn. A new departure in the hotel section is significant, the editor warning travellers that hotels which "cannot be accurately characterized without risk of legal proceedings are ignored, except when there is no other available accommodation." The remarkable development in travel facilities in the Near East is brought home very convincingly to the reader by references to electric trams in Smyrna and Damascus, motor boat services on the Sea of Galilee, motor diligences in Cyprus, and so forth.

'The Japanese in Manchuria.' Vol. 1. The Yalu and Te-li-ssu. By Colonel E. L. V. Cordonnier. Translated by Captain C. F. Atkinson. Pall Mall Military Series. (London: Hugh Rees. 1912. Pp. xl., 281. *Maps.* 7*s.* 6*d.*) The author of this volume is a colonel in the French army, and the translator, Captain C. F. Atkinson, is already well known as a writer on military subjects, and appears to have carried out his present task admirably. The volume deals with operations on and about the Yalu and Te-li-ssu, and is accompanied by a series of maps on large scales, larger, in fact, than those accompanying the original publication. They have been entirely revised in accordance with the system of transliteration used in the 'British Official History.' It may be added that the first chapter furnishes by way of introduction a brief survey of the causes of the war.

AFRICA.

'Morocco in Diplomacy.' By E. D. Morel. (London: Smith Elder. 1912. Pp. xxii., 359. *Maps.* 6*s.*) The author is well known as a writer who holds strong views on political and economic questions in Africa, and especially in West Africa, and in the present volume he presents a narrative of the dealings of the European powers with and over Morocco during the last twenty years. He quotes in his text and appendices all necessary official documents; and the Franco-Spanish treaties and the Franco-German frontier in West Central Africa are illustrated by maps. It may be added that Mr. Morel's text is not merely history but a highly critical account.

'Morocco after Twenty-Five Years.' By Dr. Robert Kerr. (London: Murray and Evenden. 1912. Pp. xvi., 364. 10*s.* 6*d.* *net.*) The experiences of one who for twenty-five years has lived and worked in Morocco, both as a missionary and as a medical officer, offer an unusual opportunity for insight into the private

and public life of this moribund empire. It is disconcerting to find this British subject deprecating the lack of British prestige in Morocco; and those who are contemplating sojourn there, especially with a view to commerce, would do well to investigate some of the statements made, which the author confirms by names and dates. Throughout the volume there are numerous anecdotes and extracts from conversations which amusingly illustrate the Moslem point of view, and the superstition and fatalism associated with his creed. The many hints for travellers and residents with regard to food, dress, medicine, etc., will be found of great practical value, as also a good and clearly engraved map which is inserted representing the Morocco of to-day; while another showing the ancient Phœnician colonies will, with the letter-press on that period, appeal to the historical student. There are over forty illustrations of topographical, pictorial, and architectural interest.

'Nyasaland for the Hunter and Settler.' By D. D. Lyell. (London: Horace Cox. 1912. Pp. xii., 104. 5*s. net.*) Practical utility is the keynote of Mr. Lyell's sportsman's guide to Nyasaland. It is full of practical advice, both for the big game shooter and the settler, and this is presented with praiseworthy conciseness. Though British East Africa has been extensively booked as the sportsman's paradise, yet the claims of Nyasaland should not be ignored. Some useful wrinkles for the sportsman are a noteworthy feature of this unpretentious little book; and all colonists would derive considerable benefit from a chapter modestly entitled "Odds and Ends of Information." Mr. Lyell describes an ingenious substitute for a bath which is new to us. He advises the camper out, who is not equipped with the ordinary indiarubber bath, simply to dig a hole in the ground and spread over it the waterproof sheet with which most tents are supplied.

'Tangier: England's Lost Atlantic Outpost. 1661–1684.' By E. M. G. Routh, F.R. HIST. S. (London: John Murray. 1912. P. 388. *Illustrations and Maps.* 12*s. net.*) One is apt to forget how large a part Portugal played in the conquest of the Mediterranean littoral of Morocco, for the Hinterland was never occupied effectively. The Portuguese managed to retain their hold on Tangier for nearly 200 years. This great naval power may, indeed, be said to have inaugurated that policy of pacific penetration which a modern power has recently found such a costly and burdensome experiment. How, at a later date, we acquired Tangier, how we governed this "lost Atlantic outpost," and why we abandoned it after twenty years' occupation, is the subject of Miss Routh's scholarly monograph. It is generally admitted that its abandonment was a grave error, its geographical position making the port a place of great strategic value. Indeed, it is a commonplace that did Great Britain now occupy both Tangier and Gibraltar, our claim to hold the keys of the Mediterranean would be unquestionable. Miss Routh has dealt vigorously and picturesquely with a well-nigh forgotten chapter of British colonial history, and her book is so thorough and exhaustive that it may be regarded as the final word on the subject. There are no less than twenty-eight maps and plans, and there is a very full index.

AMERICA.

Vegetation of Southern Brazil.

'Flora der Umgebung der Stadt São Paulo in Brasilien.' Von A. Usteri. Jena: Gustav Fischer. 1911. 271 pp., 1 map, 1 plate, 72 figs. 7*s.*

This volume consists mainly of a systematic enumeration of the species of the district mentioned in the title, but there is a more generally interesting introduction in which the types of vegetation are discussed, and their relation to the

prevailing conditions of the district. There is no very marked moist period, as the rainfall is distributed through the four seasons in such a way that there is rain at almost every season. In the summer (January—March) the rainfall is 569 mm., in the autumn 290 mm., in the winter 139 mm., and in the spring 317 mm. The average temperature for the year is 18·2° C., August being the coldest month, with an average of 15·6° C., and January the hottest with 21·7° C. A few orographical and geological remarks are added. The author distinguishes the following plant formations:—

A. *Formations on dry soil.*

(1) The Campos.—The vegetation consists of small xerophil plants and is steppe-like.

(2) The Caapueras.—These are forests which have grown up after the virgin forest had been destroyed by fire.

(3) The Caapuerões.—These forests are the same as the Caapueras but older, and the trees are taller.

(4) Matta virgem.—Primeval forest.

B. *Formations on swampy soil.*

(1) Swamp vegetation of small plants.—Under this heading, fens (Flachmoore) and moors (Hochmoore) are described, and very interesting comparisons are made with some of the fens and moors of Switzerland.

(2) Swamp forests.

For further details the book itself must be consulted. It is illustrated with numerous good photographs, and by a coloured vegetation map.

O. V. D.

THE SELKIRKS.

'The Selkirk Mountains: a Guide for Mountain Climbers and Pilgrims.' By A. O. Wheeler. Winnipeg: Stovel Co. 1912. *Maps and Illustrations.* $1.50.

Mrs. Parker and Mr. Wheeler have conferred a boon on the rapidly increasing numbers of tourists and mountaineers who visit the Selkirk mountains. Their guide book endeavours to do for Glacier House what the late Mr. Whymper's Guides to Chamounix and to Zermatt did for those alpine centres. The first chapter is mainly historical, dealing with David Thompson's explorations, railway exploration, the coming of the C.P.R. and the work of the earlier mountaineers in this region. Chapter II. consists of a fairly complete list of known peaks and passes and other places of interest which can be reached from Glacier House. The origin of the place-name, altitude, location, routes, time required, and other details of interest are given. In fact, this chapter is a sort of Conway and Coolidge's 'Climber's Guide' to the district. Chapters III. to VI. deal with the remarkable caves in the Congar valley, Golden and the upper Columbia country, the Dog Tooth and Spillimacheen mountains, the latter still very imperfectly known, and Revelstoke and the Arrow lakes. There are brief notes on glaciers by Mr. Wheeler, with a useful reproduction of the map showing the recession of the Illecilleunet glacier by the brothers Vaux of Philadelphia. The chapter on the Alpine Club of Canada, with its constitution and rules, might be more in place at the end of the book. Notes are contributed on Natural History by Prof. Marcoun, on the more conspicuous plants by Mrs. Henshaw, on clothing and equipment and on the use of the rope in climbing by Mr. J. P. Forde. The appendix contains a glossary of mountaineering terms, extracts from the Game Laws and Park Regulations, a bibliography, and an index. The numerous illustrations hardly do justice to the theme, and a more careful selection of subjects would add to the value of the guide. The map at the end of the volume, a reduction of Mr. Wheeler's beautiful survey, is also rather

disappointing as regards legibility. This guide-book has been compiled in haste and under considerable difficulties, as explained in the preface, and in consequence there are several small slips in the text which should be corrected in future editions, in which also Mrs. Parker's name might well appear on the title-page.

T. G. L.

'The British West Indies.' By Algernon E. Aspinall. (London: Pitman. 1912. Pp. xii., 435. *Maps and Illustrations.* 7*s.* 6*d.*) This volume deals with the British West Indian territories mainly in their commercial aspect, treating in detail all the subjects which are to be ranged under that heading. Prefatory chapters, however, deal with the discovery and history of the islands and with their physical conditions, and as a work of reference to the present social, political, and economic standing of the various islands the volume should serve a useful purpose, being written by one who is in constant touch with West Indian affairs. The connection between the islands and Canada receives a special chapter, and so also does the influence which the opening of the Panama canal is likely to have upon the West Indies. The book is suitably illustrated, and has a satisfactory map.

AUSTRALASIA AND PACIFIC ISLANDS.

Australian Ethnology.

'Across Australia.' By Baldwin Spencer and F. J. Gillen. 2 vols. London: Macmillan & Co. 1912. 21*s. net.*

"Spencer" and "Gillen" are names very well known to ethnologists and those who are interested in savages on account of their books, 'The Native Tribes of Central Australia' (1899), and 'The Northern Tribes of Central Australia' (1904). Their new book is somewhat of a different category, as it is designed for the general reader or unspecialized student. It gives a description of a traverse of Central Australia from south to north, and combines the experiences of both authors on various journeys, one of them having spent many years in the country, and knowing intimately a considerable portion of the centre of the continent; it has thus the additional advantage that for the greater part of the route seasonal differences are noted. We have good descriptions of the physical characters of the different portions of the country traversed, with their typical flora or fauna; it is, in other words, a sketch of the ecology of the central band of Australia. Both the authors are naturalists and good observers, and they give us a number of original observations and deductions. They especially draw attention to the reaction of plants and animals to the desert and steppe conditions, and the field naturalist, botanist, or zoologist will find much to interest him. The serious student of ethnology may be disappointed, as all the information on the tribes visited, and the illustrative photographs, have been previously published in the above-mentioned books, with the exception of a few scattered notes on the relations of the natives to certain animals and plants, how they catch, feed upon, or utilize them. The book can be confidently recommended to all those who desire to get a grasp of the conditions of existence that obtain throughout a considerable part of Australia, and it forms an admirable introduction to the geography, flora, fauna, and ethnology of the continent. Those who would like to have another aspect presented to them should read Gregory's 'The Dead Heart of Australia,' and then proceed to more special works. The work is illustrated by 365 most excellent photographs, 7 coloured plates, and 2 maps.

A. C. H.

GENERAL.

'Physical Geography for South African Schools.' By Alex. L. du Toit. (Cambridge: University Press. 1912. Pp. xii., 250. *Maps, Diagrams, and Illustrations.* 4*s.* 6*d.*) This book is an interesting attempt, and a successful one, to discuss physical geography generally on the basis of a particular region, so far as that region supplies illustrations. The author has found that colonial students fail to understand examples quoted mainly from Europe or North America in text-books written at home. For that reason he has drawn on South Africa for illustrations in the first instance, and failing South Africa, upon other parts of the continent. But he also draws examples freely from other parts of the world, and his photographs, though mostly South African, are not wholly so. The book is written in a particularly clear and interesting style, and ought to be attractive to advanced students not only in South Africa. The explanatory maps and diagrams are fair, though their number might be increased, and there is a good general map of South Africa physically coloured.

'Statesman's Year-book, 1912.' Edited by J. Scott Keltie. (London: Macmillan. Pp. lxxxiii., 1428. *Maps.* 10*s.* 6*d.*) The Statesman's Year-book has this year been able to make use very largely of recent census returns, and in connection with the Indian census a map of the distribution of population according to provinces and other major divisions is furnished, and there is also one for the United States on the same lines. Recent boundary changes are also mapped as usual, and a special map shows the progress of the United States Survey and part of that of Canada. Brief references are given to recent political events in China, Morocco and elsewhere.

'Beginnings of History.' By Ella M. McDougall. (London: Charles H. Kelly. 1912. Pp. vii., 264. *Map.* 2*s.* 6*d.*) The object of this volume is to extend the scope of historical teaching in schools, for it is pointed out that this teaching takes little account, as a rule, of the general history of the world at the earliest times. We are therefore given chapters on China, India and Egypt in addition to the treatment of the early inhabitants of Mediterranean lands and countries adjoining them. The scheme is well carried out, but the geographical factor is for the most part omitted, and in some instances, perhaps, further attention to recent research is called for. The rise of the Phœnician power, for instance, appears to be dated much later by modern authorities than it is here, and something more than incidental reference to the early Ægean civilization would have been justifiable.

'Tropical Hygiene.' By Surgeon-Gen. C. P. Lukis and Major R. J. Blackham. (London: Thacker. 1911. Pp. v., 176. *Illustrations.* 4*s.* 6*d.*) We are informed in the preface in this book that it has been designed "as a manual for the senior certificate in home hygiene of the St. John Ambulance Association, which may be obtained after a special curriculum adapted to the sanitary needs of India." The book is a useful contribution to the study of the geography of diseases, in addition to its ample detail in respect of their treatment and prevention, not only in India, but in great measure in tropical countries generally.

'Canterbury.' By G. R. Stirling Taylor. "Mediæval Towns" Series. (London: J. M. Dent. 1912. Pp. xx., 339. *Maps and Illustrations.* 4*s.* 6*d.*) 'Jerusalem.' By Colonel Sir C. M. Watson. (Same Series. Pp. x., 390.) These two volumes maintain the excellent standard of the well-known series to which they belong. No better author could be found to write the volume on 'Jerusalem' than Sir Charles Watson, and his intensely interesting text is illustrated by a large number of Lady Watson's characteristic sketches. The volume on 'Canterbury'

is illustrated with more minute detail by Catharine Kimball. The purpose of these volumes is historical in the first instance, and only descriptive in a secondary sense, but in both there are chapters giving fully sufficient detail to enable them to be used as traveller's hand-books; and for the traveller who wishes to make his journey of real value to himself there could be nothing better than these concise historical surveys.

THE MONTHLY RECORD.

ASIA.

Sir M. A. Stein's Archæological Explorations on the North-west Frontier of India.—We have received from Sir M. A. Stein a copy of a report on his explorations on this frontier in 1911–12, which includes the following items. During a prolonged tour along the Peshawar-Swat border, he was able to examine and survey extensive ruins of ancient fortified dwellings in the valleys of Palai and Bazdarra, across the administrative frontier, which had never been visited by an archæologist. They proved to date back to the Buddhist period, and the observations obtained throw light on certain aspects of the physical and social conditions then prevailing. In the Palai valley, not far from the south foot of the Shahkot pass leading into Swat, he traced a large Buddhist site known as *Butan*, probably identical with the convent with which a legend recorded by Hsuan-tsang is connected. A number of mounds are still untouched by native seekers for sculptures. Two intact Buddhist sites were subsequently discovered in tribal territory westward, near the villages of Warter and Dobandai. At the former the explorer was able to bring to light Gandhara relievos of remarkably good execution. Continuing the same tour within the Baizai tract, he was gratified to find, even within the administrative frontier, Buddhist ruins little disturbed by earlier "irresponsible digging." A rapid tour down the Indus enabled him to make an exact survey of the ruins of Kafirkot, situated below Bilot at the southern foot of the Khasor range. These remains of a walled town of pre-Mohammedan date do not appear to have been described by a qualified archæologist. They include half a dozen richly decorated Hindu temples, closely related in style to certain Hindu temples of the Salt range, but far better preserved, and, in part, larger. The graceful ornamentation owes much to Gandhara art, and the beautiful stucco decoration of the interiors is of special interest in view of the rarity in India of early specimens of such work, which is of great importance in the history of Orientalized Hellenistic art. Its survival affords striking proof of the dryness of the local climate, which is borne out by other observations also. The temples cannot be placed much later than the seventh-eighth century A.D. Subsequent digging operations at the site of Sahri-bahlol, south of Takht-i-Bahi, resulted in the clearing of six mounds all containing remains of Buddhist places of worship, which had remained in continuous occupation probably from the Kushana period down to that of the White Huns, and even later. They yielded many interesting Gandhara sculptures, besides data of importance for the history of the whole site. Instructive evidence was obtained of long-continued worship, lingering to decay. Platforms decorated in stucco, originally serving as bases for small Stupas or Viharas, had been used later as places of deposit for miscellaneous statues and relievos. The shrines seem to have repeatedly

suffered decay and destruction long before the Mohammedan conquest. The numbers of sculptures recovered is shown by the fact that those held of sufficient interest for reproduction by photography on the spot reached over 1300, while the pieces selected for removal to the Peshawar Museum made heavy loads for fourteen bullock carts. The specimens of Gandhara art work embrace all classes, from remains of colossal images to delicate relievo carvings from miniature Stupas, etc. Among other finds were large numbers of pottery fragments bearing Kharoshthi inscriptions, and a variety of cinerary urns.

Mr. Raunkiær's Expedition in East-Central Arabia.—The *Geografisk Tidskrift* (1912, Hefte VI.) gives a short preliminary account of the journey in Arabia lately carried out by Mr. Barclay Raunkiær on behalf of the Royal Danish Geographical Society (see *Journal*, vol. 39, p. 611). The traveller reached Bassora, *viâ* Baghdad, on January 21, 1912, and was cordially received by the Vali, Hassan Risa Pasha. On the 27th he proceeded overland to Koweit by the little town of Zobeir, where he was the guest of a wealthy Arab, Abdul Wahhab Mendil. At Koweit, where he was housed in the palace of Sheikh Mobarek, he was at first regarded with some suspicion, but this disappeared when it became apparent that he came with no political motive—a result largely due to the representations of Captain Shakespear, the English political agent, who gave valuable aid both by act and advice. His stay lasted twenty-six days, towards the end of which he was cared for during a sharp attack of fever by Dr. Harrison, of the American Mission. It having been arranged that he should travel to Hofuf by Bereidah and Riadh, a start was made on February 24, in company with a trading caravan of one hundred camels, bound for Nejd. The Emir of Hail was at the time engaged in a war with the tribes of the Hajara desert, and, as it was thought unsafe to take the route along Wadi Rummah, Mr. Raunkiær chose the way by the well Safah to Zilfi. He had with him six camels and three men. Nineteen days' march across belts of clayey steppe, bare sandstone plateau, and drift-sand, brought the party to Zilfi, and two more to Bereidah. A plot against Mr. Raunkiær's life was here detected, and the Emir himself, Fahad ibn Ma'amr, proved churlish, and vetoed a continuance of the journey to Aneizah. It was therefore necessary to follow Palgrave's route to Riadh *viâ* Zilfi and Mejma'a. From Ghat the way led for the most part over low sandstone plateaux, to which the name Tuweik is given. The journey to Riadh was made independently of any caravan, but with one extra man, who had been sent by the Imam of Riadh. This ruler, Abderrahman ibn Sa'ud, received the traveller courteously, and after a short stay at Riadh the latter started again in company with a caravan, the bulk of which consisted of 150 pearl-fishers bound for Bahrein. It was an unpleasant company, and as there were no merchants the journey was made more carelessly than usual. Camp was pitched in the most exposed spots, and no watch was kept at night, so that it was only through his own vigilance that Mr. Raunkiær escaped being murdered by three Beni Murrah Bedawin. After ten days' march by a route lying between those of Palgrave and Pelly, Hofuf was reached on April 8, the traveller meeting with a cordial welcome from the Turkish authorities. He stayed there but a short time, the state of his health making him anxious to hurry on to the coast. With an escort of fifty Turkish soldiers, he reached Ajer, and there took an Arab sailing vessel to Bahrein, where he was received by the British political agent, Captain D. Lorimer. He travelled home *viâ* Bombay and Trieste, reaching Copenhagen on June 2. During the whole journey from Bassora to Ajer a route-survey was carried out with prismatic compass, no more precise method being feasible owing to the

hostility of the inhabitants. Even the reading of the compass, which took place every fifteen minutes during practically the whole march, involved much difficulty. Notes were also taken of the political and economic conditions, and of the movements of the population. In spite of the difficulties involved, a number of photographs and drawings were secured. It is hoped that the results of the journey, which is regarded as a preliminary reconnaissance in view of further work in Arabia, will be published during the coming winter.

Railways in the Caucasus.—Projects for the further development of the railway system of the Caucasus have been under discussion for some time, two especially having engaged attention. They are described, respectively, in *Export*, 1911, No. 3, 1912, No. 29. The one is for a line crossing the main range about its centre and supplying a direct connection between Tiflis in the south and Vladikavkaz in the north. Joining the existing railway at or near the latter place, it would supply an important new line of communication between Trans-Caucasia and Russia, shortening the distance to be traversed by some 600 miles, and, in the view of its promoters, tending greatly to further the economic development of the former. The second project is for a line along the north-eastern shore of the Black sea—the "Caucasian Riviera," as it has been called. It would connect in the north with the existing branch *viâ* Ekaterinodar to Novorossiisk, and in the south with the Trans-Caucasian railway system at Kwaloni. It is now announced that the Russian Government has decided in favour of the first project, principally in view of its greater strategic importance; and the construction of the line across the mountains will be taken in hand almost immediately. The feeling in certain circles is, however, so strong in support of the Black sea project (it being felt that the development of the region to be traversed urgently calls for such an improvement in its communications) that a movement has been set on foot to carry the project through by private enterprise, and that this will eventually be done is stated to be certain. As to its financial success opinions differ to some extent, but it is pointed out that the region is a most fertile one, and that with its development and the extension of cultivation its unhealthiness is bound to be lessened. The commodities likely to form the chief objects of transport are said to be: corn, coal, timber, tobacco, wine, fruit, vegetables, and building stone.

Antonio de Andrade's Journey to Tibet, 1624.—This journey by the Portuguese Jesuit Andrade is of special interest as being the first made by a European across the mountain barrier north of India. Unfortunately the current accounts of it within recent years have been to a great extent erroneous, owing, no doubt, to the comparative rarity of the narrative by Andrade himself, printed at Lisbon in 1626, under the title 'Novo Descobrimento do gram Cathayo,' etc. A careful study of the journey, based on this narrative and on a wide acquaintance with all other literature bearing on the subject, has now been supplied by Mr. C. Wessels in a memoir printed in the journal *De Studien* (Jahrgang 44, Afl. No. 4, Nijmegen, 1912), which should for the future remove all excuse for misconception on the subject. The writer follows the traveller step by step, elucidating the journey by the help of other narratives of travel, and shows that no doubt can exist either as to the route followed, or as to the general trustworthiness of Andrade's account. Two principal causes seem responsible for the confusion which has existed, the one being the idea that the place Srinagar in Garhwal, passed by Andrade, was, instead, the capital of Kashmir; the other the erroneous statement of Kircher in his *China Illustrata* in regard to the extensive lake, forming the common reservoir of the Indus, Ganges, and other great rivers of this region, supposed by him to have been

visited by the Portuguese traveller. This may have given rise to the mistaken notion that Andrade visited Manasarowar. In reality the route led from Hardwar up the valley of the Alaknanda (now recognized as the main head-stream of the Ganges), and its upper branch the Vishnuganga, past the sacred resort of pilgrims, Badrinath, and so over the main chain of the Himalayas by the Mana pass (over 18,000 feet high). Here he was on ground not again reached by travellers (apart from the missionaries who followed him) until well on in the nineteenth century—even Raper and Webb (1807–8) not having pushed so far into the mountains. As regards the lake at the source of the Ganges, which Andrade describes merely as a *tanque*, Colonel Burrard has supplied the information that a small glacier-pool, 400 yards long, does exist at the source of the Ganges, and is known as Deb Tal or Deo Tal.* In crossing the pass the traveller suffered severely from frostbite, but eventually reached Chaprang or Tsaparang, on the upper Satlej, then a place of more importance than now. This was the terminus of his journey. Returning to India the same year, he set out again in 1625, and established a mission at Chaprang, which held its ground for some years, no fewer than eighteen missionaries in all taking part in the work. Further east, too, something was done, Father Cacella reaching Shigatze in 1627, and being followed on his death in 1630 by Father Cabral. This activity ceased after 1650, and an interval of sixty-five years elapsed before the next Jesuit, Desideri, entered Tibet.

AFRICA.

Hydrography of the Upper Volta Region, West Africa.—The hydrography of the region comprised within the bend of the Niger is of particular interest in view of the changes which must certainly have taken place within comparatively recent times. The subject is discussed by the well-known traveller and geologist, M. Henry Hubert, in the *Annales de Géographie* for May 15 last. The region affords a striking example of river-capture in the evident diversion of the upper section of the Black Volta from its original northerly course to its present destination in the Gulf of Guinea. This had already been pointed out by two earlier writers, who had drawn attention to the remarkable bend near Kuri as evidence of capture of the upper Volta by a stream which worked back from the direction of Mossi, and is now represented by the middle course of the Volta below Kuri. But these writers had come to no satisfactory conclusion as to the state of things which obtained before the capture. M. Hubert shows the importance in this connection of a study of the Suru, which joins the Volta at the head of its bend, and as far as 13° 45′ N. exactly continues the direction of its upper section. This watercourse traverses a tract so nearly level that the direction of its flow varies according to the season, some of the water of the Volta still making its way northward along it at the high-level stage. While the upper Volta has reached the stage of maturity, the Suru has attained that of senility, which quite fits in with the supposition that the latter was once the lower course of the former. On the other hand, the middle Volta, with its many rapids, shows all the signs of extreme youth—a fact which again harmonizes with the theory that it has effected the capture in quite recent times. What was the ultimate destination of the Volta-Suru cannot be decided from the data available, but M. Hubert points out that both the surface geology and the trend of the small intermittent streams of the region to the north indicate the existence of an hydrographic axis

* Mr. Wessels points out that this lake was already shown (as Deb Tal) in John Walker's map of 1827, and taken over by Ritter in his map of 1832.

continuing the direction of the Volta-Suru. There are evidences in the direction of Hombori of the former existence of an extensive lacustrine region, now partially filled by the desert sands, and it seems probable that the old river once terminated here, as the upper Niger did in the lacustrine region of Timbuktu. The whole system of the Volta reproduces in a striking way that of the Niger, as regards both the direction and characteristics of the several sections. The events described form part of a general process by which the Guinea coast streams have extended their basins at the expense of those further north. It is thus well to bear in mind the part which river-capture may have played in the desiccation of the northern regions.

The Anglo-Portuguese Boundary on the Zambezi.—A Parliamentary paper recently issued (Treaty Series, 1912, No. 16) embodies the final agreement arrived at towards the end of last year with respect to the boundaries between the wedge of Portuguese territory running up the lower Zambezi to the confluence of the Loangwa, and the British territories to the north and south. Fixed in general terms by the treaty of June, 1891, the boundary was subsequently surveyed by a joint commission, whose recommendations in detail, embodied in *procès verbaux* signed in November 1904 and October 1905, were provisionally confirmed by notes exchanged between the two Governments in 1906, but had not been formally ratified until last autumn. The paper now published includes the minute description of the boundary both north and south of the river, as well as a reduced copy of the 7-sheet map compiled by the Geographical Section of the General Staff, and signed on behalf of the two Governments. The territory concerned lies almost wholly west of 33° E. long., the boundary now defined commencing in the north at the intersection of 14° S. Lat. with the Zambezi-Nyasa watershed, which, being a natural feature, had not come into question. From this point to the intersection of the Loangwa with 15° S. it takes a generally direct course, which is defined by a number of beacons erected for the most part on small hills. The Loangwa is followed south to its junction with the Zambezi, south of which river the line runs due south to a point just south of the 16th parallel, which is quickly regained, and is then followed east to the left bank of the Karemwe river. This and other streams, particularly the Mkumvura, form a natural boundary almost to 32° E., when the line is again defined by isolated hills until the Mazoe river is reached, this being then adopted as the boundary as far as 33°, where the portion of the frontier thus delimited terminates.

AMERICA.

Mrs. Schäffer's Survey of Maligne Lake.—With reference to the article on this subject in the April number (p. 379), Mr. James White, formerly geographer, in turn, to the Geological Survey of Canada and the Department of the Interior, and now secretary to the Commission of Conservation, writes to point out that the lake was "surveyed" in 1875 by H. A. F. Macleod, who had been instructed to search for a practicable route for the Canadian Pacific Railway by the valley of the Maligne river. He explored its valley for 43 miles, and named the first or lower lake Medicine lake, and the upper one Sorefoot (the Maligne of Mrs. Schäffer). As he was accompanied by Valad, a well-known half-breed guide, "Medicine" is probably a translation of the Indian name. Mr. White further states that the upper lake appeared, unnamed, on the Canadian Pacific map, 1877, and on the Department of the Interior map of Canada, 1902, though omitted from the map of Alberta recently issued by the same Department. It may be observed, however, that in the map of 1902 the lake bears no resemblance to the reality either in size or contours. This may

be due in part to its comparatively small scale, but it suggests the question how far the work of Macleod can be correctly spoken of as a "survey," at least as far as Maligne lake (a name which Mr. White approves as preferable to Sore-foot) is concerned. At all events, Mrs. Schäffer deserves the full credit of having first made the lake generally known in its correct outlines.

Is the Eastern Coast of North America sinking?—The general opinion that the Atlantic seaboard of North America has been and still is sinking at a slow but constant rate, is contested by Dr. D. W. Johnson, of Harvard University, who has for some time paid close attention to the subject. Recently, aided by a grant from the Shaler Memorial Fund of that University, and with the collaboration of various assistants, he has made a study of the most important points along the whole coast from Prince Edward Island in the north to the Keys of Florida, and has put forward the preliminary results both in *Science* and in the *Annales de Géographie* (May 15, 1912); the full discussion being reserved for the *Shaler Memorial Series of Harvard University*. In the paper in the *Annales* Dr. Johnson discusses the supposed proofs of recent subsidence, and endeavours to show that in each case the facts may be explained otherwise, or that the movement, if it took place, was of so ancient a date that it does not affect the question at issue. A good many supposed evidences of change of level are, he holds, purely illusory. Thus, in the case of ancient buildings now partially below sea-level, the facts are in his view to be explained by the action of the sea in uncovering foundations which even when laid were below the level of low-tide. Another and more important class of supposed proofs rests on the occurrence of trees killed by an invasion of the sea, of trunks submerged beneath the water, or of peat beds also occurring below low-water mark. All these instances, Dr. Johnson holds, are quite consistent with the idea of a stability of the coast for at least some thousands of years. Dead standing trees were frequently found to have been killed either by fire or by the normal encroachment of the sea, which had saturated the soil in which they grew with salt water. In many cases the supposed trunks are in reality the stout tap-roots of trees like the Loblolly pine, of which the trunks grew above the water-level. Peat-beds, now submerged, have had their surface lowered by compression of the material either from the deposit upon it of masses of sand or by the lowering of the ground-water level. But still more of the supposed instances can be explained as due to a local change in the level of high-water. Within a bay or lagoon nearly cut off from the sea by a sand bar, the range of the tide will be far less than on an exposed part of the coast, and if the bar is swept away there will be a local rise in the high-tide level, by which trees growing on the shores of the bay will be killed. On the other hand, there are many facts which argue a stability of level for several thousands of years. The enclosed bays or lagoons above referred to are constantly fringed with miniature cliffs and platforms formed before the accumulation of the bars—a work of many centuries—but they occupy a level exactly corresponding to that which would still be reached by the sea were the obstruction removed. It is also important to note that the supposed indications of subsidence are not continuous along the coast, but occur at such spots as are specially subject to the action of *local* causes.

Exploration of the Ibera Lagoon, Argentine Republic.—The full report of Colonel Pedro Uhart on the recent investigation of this lagoon on behalf of the Sociedad Cientifica Argentina (*Journal*, vol. **38**, p. 535) has now appeared in the *Annales* of that body (vol. **72**, part 4, 1911). The exploration was carried out in 1910 under considerable difficulties by means of a petrol launch and boats, progression being effected either by towing, punting, or, on occasion, by

sailing. Instead of making a series of traverses from shore to shore, it was decided to navigate the axis of the swamp, obtaining a general idea of its contours by triangulation, this work being entrusted to Señor Esteve. The scene of action was approached from the south by the Rio Corrientes, one of the main drainage channels of the swamp—a winding water-course which had inundated its banks at the time, it being the period of high water. The navigation was continued in a generally north-east direction (with a detour to the south-east for the examination of the Ibera lagoon proper, an expanse of open water on that side of the marshes) to the Naranjito lagoon towards the northern end. The boats then returned while further exploration of the shores was effected on foot. The facts observed in regard to the general character and *régime* of the marshes are of much interest. Their total extent is reckoned at 6000 square kilometres or 2300 square miles, and they are bounded on the north by a band of consolidated sandy deposits resting on a base of red sandstone—a formation which seems to underlie the whole area, forming a more or less impermeable substratum. One of the questions to be solved was that of the relation of the marshes to the Paraná, which flows at but a short distance from their northern end. It was found by careful levelling that the marshes lie at a higher level than that river, and any relation existing between the rise of the two is due to the coincidence of the rains in their gathering grounds. The marshes depend wholly for their supply on the rains which fall over an area of 12,000 square miles, reckoned at at least 40 inches yearly. Of the total supply probably three-fifths is lost by evaporation, the remainder being carried off either by filtration or by the effluents, of which there are three, in the north, south-east, and south-west respectively. The presence of gravel and other minerals not occurring *in situ* in the district, but identical with those found on the Alto Paraná, favours the view that a channel of this river formerly traversed the marshy area. The band of consolidated sands which now shut off the river is of quite recent formation, and as the Paraná in this region is traversed by frequent dykes which cause rapids in its course, it seems probable that the river channel once stood at a higher level, but has been lowered by the wearing away of the dykes. A rough estimate puts the extent of open water at 1000 square kilometres (386 square miles) of which about 85 per cent. is accounted for by the six principal lagoons. The rest of the area is blocked by the growth of vegetation, but a network of channels makes communication by boat possible throughout, at least at high water. While hesitating to express an opinion as to the desirability of draining the marshes, and the possible effect of such an operation on the climate, Colonel Uhart recommends that steps be taken for improving navigation by clearing out the channels, especially of the outlets, which would also have the effect of allowing the water to pass away more quickly and so diminishing the extent of the inundations.

AUSTRALASIA AND PACIFIC ISLANDS.

New Dutch Expedition to New Guinea.—On August 15 a new Dutch expedition to New Guinea left Surabaya. The members of the expedition are Captain Franssen Herderschee, leader, formerly on the Mamberamo expedition; Dr. A. Pulle, botanist; Dr. P. Hubrecht, geologist; Dr. G. M. Verslag, surgeon and zoologist; Lieut. D. Habbema, in command of 40 soldiers; a native surgeon; 150 Dayaks and 40 convicts. The expedition will last about nine months. It is proposed to make collections in the regions from 7000 feet to the snow limit, and also to explore the mountains north of Wilhelmina peak. The expedition starts from the south coast, and follows the Lorentz river and the route traversed by Dr. Lorentz to the snows.

POLAR REGIONS.

Safety of Mikkelsen.—The grave anxiety felt by all interested in the fate of the Danish explorer Mikkelsen has been happily relieved by the news of his rescue by the Norwegian fishing vessel *Sjöblomsten*, after all hope of his safety had been abandoned in most quarters. It will be remembered that when the rest of his expedition was brought home in the autumn of 1910, he himself, with his companion the engineer Iversen, had not returned to the base station on the east coast of Greenland. Hopes were then entertained that the two hardy explorers might be able to make their way across the inland ice to the Danish settlements on the west coast, but when another full year passed with no tidings of the missing men, the gravest fears seemed justified. According to the news telegraphed from Aalesund, where the *Sjöblomsten* arrived on July 27, the two explorers, who had left the rest of the expedition on their northern journey on April 10, 1910, proceeded over the inland ice to Denmark fjord, where they were successful in finding the records left there by Mylius Erichsen. The return journey was begun on May 29, 1910, but was attended with great hardships. Many of the dogs died and the rest had to be killed for food. Reaching Shannon island on November 29, 1910, the two men appear to have wintered there and to have gone in the spring of 1911 to Skaargaerds-fjord in order to fetch the journals of Mylius Erichsen which had been left there. In the autumn of last year, having been disappointed in their hope of being rescued by Norwegian whalers, they went over the ice to Bass rock, where they spent their third winter, and where they were eventually found, having been too weak to complete a sledge journey which they tried to make to Cape Delton. When rescued they had themselves almost abandoned hope of being saved, as their provisions were nearly at an end. In spite of the indescribable hardships they had suffered, they both reached Aalesund in good health. The reports of Mylius Erichsen found at Denmark fjord give an account of that ill-fated explorer's work in the far north, mentioning, *inter alia*, the discovery that Peary channel does not run through from sea to sea behind Hazen and Heilprin lands.

Dr. Charcot in Jan Mayen.—Writing from Isa fjord in Iceland on July 28, Dr. Charcot briefly reports on his visit to Jan Mayen early in the present summer. A visit to Egg island was of interest in view of the question which lately arose as to the supposed emission of steam from its crater (*Journal*, vol. **38**, p. 537; **39**, p. 79). Landing in the interior of the crater on July 21, Dr. Charcot found that not only was there no sign of recent activity, but that snow lay on the narrow beach, though there was hardly any elsewhere on Jan Mayen, except on the Beerenberg. A slight wind quickly raised a cloud of dust and sand from the beach, and the same phenomenon, which might easily be mistaken for smoke, was observed in many other parts of the island. At Mary Muss bay it was found that the Austrian depôt no longer existed, even the coal having nearly all been burnt, most likely by Norwegian hunters who wintered there in 1911. The houses, however, were in good condition. Although not favoured by weather until the Arctic circle had been crossed, Dr. Charcot reports that some good work had been done by the naturalists. Some good photos of Jan Mayen had been secured, and Madame Charcot had made a capital colour-sketch of the whole of the island.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Air Temperatures on Mountains and in the Free Atmosphere.—With the development of observations of the free air by means of balloons and kites, material has been gradually accumulating for a comparison of the

temperature of the air on mountains and at the same elevation in the free atmosphere. Formerly the data obtained at mountain observations supplied practically the only basis of a knowledge of the conditions of the upper layers, but it has for some time been realized that the records at mountain stations are by no means trustworthy guides to the corresponding facts away from the influence of the Earth's surface. The careful series of upper air observations made by Assmann in Central Germany since 1903, in conjunction with the records obtained at the Observatory founded by him on the Brocken in 1895, now permit a more satisfactory comparison of the temperatures at the two kinds of stations, under otherwise similar conditions, than is often possible, and such has lately been made by Dr. Alfred Hildebrandt in No. VII. of the *Geographische Arbeiten herausgegeben von Dr. Willi Ule* (Stuttgart, 1912). The writer begins by summarising the results of similar studies in the past, showing that while in most cases it has been proved that the mean temperature at the mountain station is the *lower*, the reverse state of things has been found by some observers to exist, at least at certain seasons. Dr. Hildebrandt's study confirms the view that the air at mountain stations is usually the cooler—a fact which has been ascribed both to the effect of radiation, and also to the cooling by expansion of ascending air-currents. A mean of all the values used gives a temperature of 3·5° C. (38·3° Fahr.) for the free air, and 2·8° C. (36·7° Fahr.) for the Brocken—a difference of 0·7° C. (1·2° Fahr.). This state of things is maintained throughout the year, the Brocken being the colder in each separate month, though the amount of the defect of temperature of course varies. The state of the weather has an important influence in the matter, cyclonic conditions generally depressing the temperature at the mountain station relatively to the other. An examination of the night temperatures shows a mean defect in the case of the Brocken of 1° C. (1·8° Fahr.)—a fact which is not surprising in view of the nightly radiation. What was perhaps less to be expected was the fact that even in the midday hours (except between noon and 1 p.m.) the mean for the Brocken was no higher than that for the free air.

Depth of the Zone of Flow in the Earth's Crust.—The question of the depth below the surface at which the rocks forming the Earth's crust begin to flow is of importance not only from the point of view of general geology, but from its practical bearing on the probable depth to which mineral-bearing fissures may extend. Some progress towards its solution has been made through experiments carried out by Mr. Frank D. Adams of McGill University, who has made known the results in the *Journal of Geology*, No. 2, 1912. Previous attempts at a solution, such as that undertaken for President Van Hise by Prof. Hoskins, have been based on a large number of assumptions, some of which are far from being justified in reality. Hoskins's calculations gave 12,000 metres, or between 7 and 8 miles, as the depth at which not only all cavities would close, but the hardest rocks would flow; but as nearly all the corrections probably required would tend to *lower* the figures, Van Hise considered that the depth suggested was much, probably twice, too great. The subject was approached in 1904 in the address delivered before Section C of the British Association by the Hon. Charles A. Parsons, who afterwards, in reply to correspondence in *Nature*, put forward the suggestion that light might be thrown on the question by subjecting a cylinder of granite or quartz rock, fitted into a steel mould and having a hole bore through its centre, to a very high pressure. It is on these lines that Mr. Adams's experiments have been carried out. Among the factors not taken into account in Prof. Hoskins's estimate the most important were:

(1) the influence of pressure upon rigidity in the deeper parts of the crust; (2) that of the higher temperature found at such depths; (3) the effect of long-continued, as compared with temporary, pressure. It is possible to reproduce approximately the conditions of pressure and temperature probably obtaining at various depths below the surface, while the necessarily restricted period during which the experiment can be continued can be made up for in part by a proportional increase of pressure. It is possible to give here only a brief summary of the conclusions arrived at. They show that previous calculations, based on the crushing strength of rocks at the surface, are erroneous. At ordinary temperatures, but with the conditions of hydrostatic pressure or cubic compression which exist within the crust, granite will sustain a load of nearly 100 tons to the square inch—a load more than seven times as great as will crush it at the surface. Under the conditions of pressure and temperature believed to obtain within the crust, empty cavities may exist in granite to a depth of at least 11 miles. They may extend to still greater depths, and if filled with water, gas, or vapour will certainly do so, owing to the pressure exerted by such fluids or gases on the walls of the cavities. It follows that mineral veins and replacement deposits may be formed within the crust to a depth of at least 11 miles, or much beyond any depth to which it is possible to follow them by existing methods.

Icebergs and Navigation.—The issue of *Nature* for June 20 contains the abridgment of a discourse on this subject delivered at the Royal Institution by Prof. Howard T. Barnes, F.R.S., on May 31, and rendered particularly appropriate by the recent disaster to the *Titanic*. In order to test the influence of icebergs on the water temperature, Prof. Barnes has devised a practical form of electrical-resistance thermometer capable of recording thousandths of a degree of temperature, which he calls the micro-thermometer, and which works on the well-known principle of the electrical-resistance thermometer. The temperature influence of an iceberg, which Prof. Barnes calls the "iceberg effect," is peculiar, consisting first of all of a rise of temperature, followed by a rapid fall. This characteristic would, of course, be entirely missed by an ordinary sluggish mercurial thermometer. The preliminary rise of temperature is due to fresh water, such as that observed by Pettersson in his tank experiments. The light fresh water, in flowing out from the melting berg, starts colder than the sea, and gradually becomes warmer as the distance from the berg increases, till at its fringe the temperature is actually higher than the sea temperature owing to absorption of the sun's rays. In the open sea, of course, such solar heating is offset by the vertical circulation. Of greater practical importance perhaps than even the study of ice influence, is that of the effect of land on the temperature of the sea. The coast of Labrador has been found by Prof. Barnes to exert an influence in turning up the colder under-currents of the Arctic stream, for whenever the ship steamed in towards the coast-line the temperature was found to fall one or two degrees, the limit of the influence appearing to be about 5 miles. The chilling effect of land was also noticed in the Bristol channel and other places. The icebergs of the North Atlantic are mainly derived from Western Greenland, and they may be met with anywhere in that ocean north of the fortieth parallel at any season of the year. The ice "blink" is a peculiar whiteness observed round the berg on a dark night before ice can be seen, and is due to the reflection of the scattered rays of light from the sky by the white surface of the berg. Icebergs are sometimes detected by the echo from the steam-whistle or fog-horn; sometimes by the thunder-like noise of breaking-up ice; or occasionally by the absence of swell or waves, or the presence of flocks of birds. A peculiar damp cold usually betokens approximation to ice.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
Jber. = Jahresbericht.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. = (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Baltic—Towns. *Ymer, Ts. Svenska S.G.* **32** (1912): 41–87. **De Geer.**

Storstäderna vid Ostersjön. Af Sten De Geer. *Plan and Diagrams.*

Belgium—Ardennes. **Vliebergh and Ulens.**

A.R. de Belgique, Mém. II. Série, **8** (1912): fasc. I. (pp. 428).

L'Ardenne. La population agricole au XIXe siècle. Contribution à l'étude de l'histoire économique et sociale. Par Em. Vliebergh et Rob. Ulens. *Maps.*

Central Europe—Zoogeography. *Deuts. Rundschau G.* **33** (1910–11): 359–371. **Brehm.**

Der Einfluss glazialer und postglazialer Verhältnisse auf die niedere Tierwelt Mitteleuropas, speziell auf deren geographische Verbreitung. Von Dr. V. Brehm.

Denmark—Language. **Poestion.**

Lehrbuch der Dänischen Sprache für den Selbstunterricht. Von J. C. Poestion. 3. Aufl. (Die Kunst der Polyglottie . . . 16. Teil.) Vienna, etc.: A. Hartleben, [*not dated*]. Size 7 × 4½, pp. viii. and 184. *Price* 2 *kr.* 20. *Presented by the Publisher.*

Europe—Earth-movements. *Z. Ges. E. Berlin* (1912): 249–250. **Braun.**

Ueber Bodenbewegungen in Mittel- und Südeuropa. Von G. Braun.

Europe—Morphology. *La G., B.S.G. Paris* **25** (1912): 73–90. **Sawicki.**

Le Massif central français et le massif de Bihar. Parallèle morphologique. Par Ludomir Sawicki. *Illustrations.*

Recently noticed in the Monthly Record.

France—Alps. **Tardieu.**

Les Alpes de Provence. Guide du Touriste, du Naturaliste et de l'Archéologue. Par Gustave Tardieu. Paris: Masson et Cie., 1912. Size 7 × 4½, pp. vi. and 310. *Sketch-maps, Illustrations, and Section. Presented by the Publishers.*

France—Aveyron. *B.S.G. Lille* **57** (1912): 150–164. **Brienne.**

Les Segalas du Rouergue. Par M. M. Brienne. *Illustrations.*

Segalas are light sterile soils associated with crystalline rocks.

France—Census. *Rev. Française* **37** (1912): 90-100. **Cilvanet.**

Le recensement de 1911 en France. Par C. Cilvanet. *Sketch-maps.*

France—Determination of position. *C.R.A. Sc. Paris* **154** (1912): 497-499. **Rabioulle.**

Résultats des déterminations des co-ordonnées géographiques de la station astronomique du Pic du Midi de Bigorre, au moyen de l'astrolabe à prisme et de l'heure radiotélégraphiée de Paris. Par Émile Rabioulle.

France—Langres. *Rev. G. Ann.* **5** (1911): [No. II.], pp. 206. **Masson.**

Le plateau de Langres. Par Dr. H. Masson. *Sketch-maps, Sections, Diagrams and Illustrations.*

France—Panoramas. *La G., B.S.G. Paris* **25** (1912): 251-256. **Glangeaud.**

Les tables d'orientation et l'éducation géographique du public. Par Ph. Glangeaud. *Illustration.*

On a possible improvement of the panoramas from noted view-points supplied for the benefit of tourists.

France—Puisaye. *Rev. G. Ann.* **5** (1911): [No. I.], pp. 148. **Goujon.**

La Puisaye: Essai de définition d'une région naturelle du bassin de Paris. Par G. Goujon. *Sketch-maps, Illustrations, Diagrams, and Sections.*

France—Savoy—Alps. **Gaillard.**

Les Alpes de Savoie. (Premier volume.) Les massifs entre l'Arc et l'Isère. Guide pour l'alpiniste. Par Émile Gaillard. Macon: C. Faurie, [1912]. Size 7 × 4½, pp. xviii. and 224. *Maps. Presented by the Publisher.*

Germany—Bavaria—Lakes. *Deuts. Rundschau G.* **34** (1911-12): 213-224. **Reindl.**

Die bayrischen Hochseen. Von Dr. Josef Reindl. *Maps and Illustrations.*

Germany—Eifel. **Follmann**

Die Eifel. Von Otto Follmann. (Land und Leute: Monographien zur Erdkunde . . . herausgegeben von Ernst Ambrosius. 26 Heft.) Bielefeld, etc., Velhagen & Klasing, 1912. Size 10 × 7, pp. iv. and 126. *Map and Illustrations. Price* 4*m.*

Germany—Hessen—Anthropology. **Greim.**

Forschungen deuts. Landes- u. Volksk. **20** (1912): 1-144.

Beiträge zur Anthropogeographie des Grossherzogtums Hessen. Von Prof. Dr. Georg Greim. *Sketch-maps.*

Germany—Historical. **Kossinna.**

Die deutsche Vorgeschichte, eine hervorragend nationale Wissenschaft. Von Gustaf Kossinna. (Mannus-Bibliothek; herausgegeben von Prof. Dr. Gustaf Kossinna, Nr. 9.) Würzburg: C. Kabitzsch, 1912. Size 10½ × 7, pp. viii. and 100. *Illustrations. Price* 6*m. Presented by the Publisher.*

Germany—Prussia. **Conwentz and others.**

Das Plagefenn bei Chorin: Ergebnisse der Durchforschung eines Naturschutzgebietes der Preussischen Forstverwaltung. Von H. Conwentz u. a. (Beiträge zur Naturdenkmalpflege, herausgegeben von H. Conwentz; 3. Bd.) Berlin: Gbr. Borntraeger, 1912. Size 10 × 7, pp. xvi. and 688. *Maps and Illustrations. Price* 18*m.* 75.

An elaborate study of the soil and natural productions of a district lately set apart as a reserve.

Germany—Relief. **Schlüter.**

Zur Geschichte der deutschen Landschaft (vorläufige Mitteilung). Von Otto Schlüter. (Sonderabdruck aus den Mitteilungen der Naturforschenden Gesellschaft zu Halle a. S., Bd. I.) Halle, 1911. Size 9 × 6, pp. 10. *Sketch-map.*

See note in the Monthly Record for August.

Greece—Archipelago. **Ross.**

L. Ross. Inselreisen. 1. Teil. . . . Redivierte Ausgabe. (Klassiker der Archäologie . . . Band I.) Halle a. S.: M. Niermeyer, 1912. Size 9 × 6, pp. xxiv. and 182. *Portrait and Illustrations. Price* 3*s.* 6*d.*

The first volume of a reprint of Ross's 'Reisen auf den griechischen Inseln des ägäischen Meeres,' published in 1840.

Greece—Athens—Meteorology. **Schmidt and Knoch.**

Abh. K. Preuss. Met. Inst. **4** (1911): No. 5, pp. 39.

Zur Meteorologie von Athen. Witterungsaufzeichnungen 1863-1879. Messungen der Radien des Mondhalo von 22°. Nordlichtbeobachtungen von J. F. Julius Schmidt. Bearbeitet von K. Knoch. *Illustrations.*

Italy. **Baedeker.**

Southern Italy and Sicily, with excursions to Sardinia, Malta, and Corfu. Handbook for travellers by Karl Baedeker. 16th edit. Leipzig (London: T. Fisher Unwin), 1912. Size 6½ × 4, pp. lvi. and 508. *Maps and Plans. Price* 6*s. Presented by the Editor.*

Italy—Rome. **Inman.**

Rome. The cradle of Western civilization as illustrated by existing monuments. By H. I. Inman. London: Edward Stanford, Ltd.,1912. Size 6½ × 4, pp. xii. and 298. *Plans. Price* 4*s. net. Presented by the Publisher.*

United Kingdom—Cornwall. **Folliott-Stokes.**

The Cornish coast and moors. By A. G. Folliott-Stokes. London: Greening & Co., 1912. Size 8½ × 5½, pp. 368. *Illustrations. Price* 12*s.* 6*d. net. Presented by the Publishers.*

United Kingdom—Cornwall. **Stone.**

England's Riviera. A topographical and archæological description of Land's End, Cornwall, and adjacent spots of beauty and interest. By J. Harris Stone. London: Kegan Paul, Trench, Trübner & Co., 1912. Size 9½ × 6, pp. xii. and 492. *Illustrations. Price* 15*s. net. Presented by the Publishers.*

United Kingdom—Lancashire. **Marr.**

Cambridge County Geographies (edited by Dr. F. H. H. Guillemard). North Lancashire. By Dr. J. E. Marr. Cambridge: University Press, 1912. Size 7½ × 5, pp. xii. and 180. *Maps, Illustrations, and Diagrams. Price* 1*s.* 6*d. Presented by the Publishers.*

United Kingdom—London. **Baedeker.**

London and its environs. Handbook for travellers by Karl Baedeker. 16th revised edition. Leipzig: Karl Baedeker, 1911. Size 6½ × 4½, pp. xxxviii., 454, and 58. *Maps and Plans. Price* 6*m. Presented by the Publisher.*

United Kingdom—Scotland—Historical. **Hyslop.**

Langholm as it was. A history of Langholm and Eskdale from the earliest times. By John Hyslop and Robert Hyslop. Sunderland: Hills & Company, 1912. Size 9 × 6, pp. xvi. and 922. *Maps and Illustrations. Presented by the Publishers.*

United Kingdom—Scotland—Text-book. **Frew.**

A Junior Geography of Scotland. Regional and Practical. By David Frew. London: Blackie & Son, 1912. Size 7½ × 5½, pp. 96. *Sketch-maps. Price* 1*s. Presented by the Publishers.*

ASIA.

Chinese Empire—South-East Tibet. **Bacot.**

Jacques Bacot. Le Tibet révolté: vers Népémakö, la terre promise des Tibétains. Paris: Hachette et Cie., 1912. Size 9½ × 6, pp. 366. *Maps and Illustrations. Price* 15 *fr. Presented by the Publishers.*

India—Abor expedition. **Hamilton.**

The Abor expedition. By Angus Hamilton. (From the *United Service Magazine*, vol. 166, May, 1912.) London, 1912. Size 9½ × 6, pp. 153-167.

India—Berar. *Records Geol. Surv. India* **41** (1912): 266-285. **La Touche and Christie.**

The geology of the Lonar Lake. By T. H. D. La Touche. With a note on the Lonar Soda Deposit. By W. A. K. Christie. *Sections.*

See note in the July number.

India—Burma. **Dautremer.**

Joseph Dautremer. Une colonie modèle: Birmanie sous la régime britannique. Paris: E. Guilmoto, 1912. Size 9 × 5½, pp. 300. *Maps and Illustrations. Presented by the Publisher.*

India—Burma—Ethnology. **Rose and Brown.**

Mem. Asiatic S. Bengal **3** (1910): 249-277.

Lisu (Yawyin) Tribes of the Burma-China Frontier. By Archibald Rose and J. Coggin Brown. *Sketch-map and Illustrations.*

India—Burma—Geology. *Records Geol. Surv. India* **41** (1912): 240-265. **Stuart.**

The geology of the Henzada District, Burma. By Prof. Murray Stuart.

India—Census. *J.R.S. Arts* **60** (1912): 501-515. **Gait.**

The Indian Census. By E. A. Gait.

India—Game protection. *P. Zool. S.* (1912): 23–55. **Stebbing.**

Game Sanctuaries and Game Protection in India. By E. P. Stebbing.

India—Ganges Delta. **Ascoli.**

The rivers of the Delta. By F. D. Ascoli. (From the *Journal and Proceedings, Asiatic Society of Bengal*, New Series, vol. 6, No. 10, 1910.) [Calcutta, 1910.] Size 9½ × 6, pp. 543–556. *Sketch-maps.*

See note in the June number (vol. 39, p. 611).

India—Himalaya—Geology. *Mem. Geol. Survey India* 36 (1912): 202–360. **Diener.**

The Trias of the Himalayas. By Dr. C. Diener. *Sections.*

India—Historical. **Foster.**

The English factories in India, 1637–1641. A calendar of documents in the India Office, British Museum, and Public Record Office. By William Foster. Oxford: Clarendon Press, 1912. Size 9 × 6, pp. xlvi. and 340. *Illustration. Presented by the India Office.*

India—North-East Frontier. *Fortnightly Rev.* 91 (1912): 552–565. **Hamilton.**

The Mishmi Mission. By Angus Hamilton.

India—North-East Frontier. *J.R.S. Arts* 60 (1912): 379–392. **Holdich.**

The North-Eastern Frontier of India. By Colonel Sir Thomas H. Holdich.

India—Surveys. **Survey of India.**

Records of the Survey of India. Vol. 1: 1909–10. Prepared under the direction of Colonel S. G. Burrard. Calcutta, 1912. Size 13 × 8½, pp. ii. and 142. *Maps and Illustrations. Presented by the Survey of India.*

This publication replaces the former 'Extracts from Narrative Reports' of the Survey of India, and gives detailed sectional reports on the work of the year; the 'Annual Report' being now a condensed general summary.

Japan—Aki. *J. Tōkyō G.S.* 23 (1911): 799–801. **Nishimura.**

On the Saijō Basin in the Province of Aki. By M. Nishimura. [In Japanese.]

Japan—Asama-yama. *B. Imp. Earthquake Investigation Com.* 6 (1912): 1–147. **Omori.**

The eruptions and earthquakes of the Asama-yama. By Dr. F. Omori. *Sketch-maps, Diagrams, and Illustrations.*

See note in the Monthly Record, July.

Japan—Ethnography. **Huntington.**

Geographical environment and Japanese national character. By Dr. Ellsworth Huntington. (From the *Journal of Race Development*, vol. 2, No. 3.) [Worcester, Mass.], 1912. Size 9½ × 6, pp. 256–281.

Noticed in the June number, p. 596.

Russia—Siberia. **Gmelin.**

Johann Georg Gmelin, 1709–1755, der Erforscher Sibiriens. Ein Gedenkbuch (herausgegeben von Otto Gmelin). Munich: Otto Gmelin, 1911. Size 9½ × 7, pp. vi. 146. *Portrait. Price M.*7.50.

An interesting selection of material on the naturalist traveller Gmelin (the elder) and his Siberian researches, in commemoration of the centenary of his birth. It includes a memoir and appreciation of Gmelin, and a reprint of the masterly introduction to his 'Flora Siberica.'

Russian Turkestan. **Olufsen and Paulsen.**

The Second Danish Pamir Expedition, conducted by Lieut. O. Olufsen. Studies on the vegetation of the Transcaspian Lowlands. By Ove Paulsen. Copenhagen: Glydendal, 1912. Size 10 × 7, pp. iv. and 280. *Map and Illustrations. Presented by the Author.*

AFRICA.

British East Africa. **Ward and Milligan.**

Handbook of British East Africa, 1912. Compiled by H. F. Ward and J. W. Milligan. Nairobi (London: Sifton, Praed, & Co.), 1912. Size 8 × 5, pp. xxiii. and 314. *Maps and Illustrations. Price 4s. 6d. net. Presented by the Publishers.*

Canary Islands. **May.**

Gomera: die Waldinsel der Kanaren. Reisetagebuch eines Zoologen, von Walther May. Karlsruhe: G. Braun, 1912. Size 10 × 6½, pp. x. and 214. *Sketch-maps and Illustrations. Price 3s.*

Cape Colony—Geology. **Department of Mines.**

Cape of Good Hope. Department of Mines. Fifteenth annual report of the Geological Commission, 1910. Cape Town, 1911. Size 9½ × 7¼, pp. 142 and vi. *Maps and Sections.*

Cape Verde Islands. **Eveleigh.**

The Cape Verde Islands. An essay on the history, geography, and inhabitants of the islands, Marine Mollusca, etc. By Rev. G. S. C. Eveleigh. St. Vincent, 1911. Size 7½ × 5, pp. 70. *Sketch-map and Illustrations.*

Central Africa—Frontier survey. **Maury.**

Les régions voisines de la frontière orientale du Congo belge du Tanganyka au lac Albert, d'après les travaux des missions cartographiques et géodésiques belges. Par M. J. Maury. Brussels, 1912. Size 9½ × 6, pp. 70. *Sketch-maps and Illustrations.*

Central Africa—Zambezi-Congo Watershed. **Bencke.**

Deuts. Rundschau G. **32** (1909–10): 69–75.

An der Wasserscheide zwischen Kongo und Zambesi. Von Albert Bencke. *Map.*

East Africa—Zoogeography. *Ymer* **31** (1911): 201–222. **Lönnberg.**

Den svenska zoologiska expeditionen till Ostafrika, 1910–1911. Af Einar Lönnberg. *Illustrations.*

Egypt—Irrigation. **Pacha.**

Dr. Abbate Pache. Encore le Canal Abbas II. Solution du problème des irrigations en Egypte. Mémorandum, Cairo, 1912. Size 11 × 7½, pp. 40. *Map.*

Egypt—Magnetic Survey. **Survey Department.**

Ministry of Finance, Egypt. Survey Department. Magnetic Survey of Egypt. Values of the Magnetic Elements at 81 Stations. Cairo, 1911. Size 10½ × 7, pp 6. *Map.*

Egypt—Meteorite. **Ball.**

Ministry of Finance, Egypt. Survey Department Paper, No. 25. The meteorite of El Nakhla el Baharia. By Dr. John Ball. Cairo, 1912. Size 10½ × 7½, pp. 20. *Sketch-maps and Illustrations.*

Egypt—Nile Flood. **Craig.**

Ministry of Finance, Egypt. Survey Department Paper, No. 26. The rains of the Nile Basin and the Nile Flood of 1910. By J. I. Craig. Cairo, 1912. Size 10½ × 7, pp. 110. *Maps and Diagrams.*

This has been noticed in the Monthly Record.

Egypt—Siwa Oasis. *J. African S.* **11** (1912): 290–324. **Stanley.**

The Oasis of Siwa. By C. V. B. Stanley. *Sketch-map and Illustrations.*

French Chad Territory—Fort Lamy. **Lame and Ferrandi.**

Renseignements Col. Afrique française (1912): 101–111.

Fort-Lamy, chef-lieu du territoire du Tchad. Par le capitaine Lame et le lieutenant J. Ferrandi. *Sketch-map.*

French Congo—Stanley Pool. *Ann. G.* **21** (1912): 57–69. **Le Gallois.**

Contribution à la cartographie du Congo français. Région du Stanley Pool. Par A. Le Gallois. *Map.*

French Equatorial Africa. *La G., B.S.G. Paris* **25** (1912): 99–102. **Roussilhe.**

Mission hydrographique Congo—Oubangui—Sanga. Par H. Roussilhe.

This mission was referred to in vol. **38**, p. 532.

French Sudan. *La G., B.S.G. Paris* **25** (1912): 153–172. **Gironcourt.**

Le Sommet de la boucle du Niger. Géographie physique et botanique. Par G. de Gironcourt. *Map and Illustrations.*

Morocco. **Gentil.**

Le Maroc physique. Par Louis Gentil. Paris: F. Alcan, 1912. Size 7½ × 5, pp. 320. *Price 3 fr. 50. Presented by the Publisher.*

Tripoli. **Bernet.**

Edmond Bernet. En Tripolitaine; voyage à Ghadamès, suivi des Mémoires du Maréchal Ibrahim-Pacha, ancien-gouverneur, sur son œuvre en Tripolitaine avant

la guerre. Paris: Fontemoing et Cie., 1912. Size 10 × 6½, pp. x. and 266. *Sketch-map and Illustrations. Price* 7.50 *fr.*

Tripoli. **Vatter.**

Tripolitanien. Grundzüge zu einer Landeskunde: Von Dr. Ernst Vatter. Strassburg and Leipzig, Josef Singer, 1912. Size 9 × 5½, pp. iv. and 174. *Sections. Presented by the Author.*

Tripoli. **Vinassa de Regny.**

P. Vinassa de Regny. Libya Italica. Terreni ed Acque, Vita e Colture della Nuova Colonia. Milan: Ulrico Hoepli, 1913 [1912]. Size 9½ × 6½, pp. xvi. and 214. *Maps and Illustrations. Price* 7.50 *lire. Presented by the Publisher.*

NORTH AMERICA.

Canada—North-West Territory. **Seton.**

The Arctic Prairies. A canoe journey of 2000 miles in search of the Caribou; being the account of a voyage to the region north of Aylmer Lake. By Ernest Thompson Seton. London: Constable & Co., 1912. Size 9 × 5½, pp. xvi. and 416. *Sketch-maps and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publishers.*

North America—Text-book. **Heaton.**

The Junior Scientific Geography. Book VI. The Atlantic seaboard and North America. By Ellis W. Heaton. London: Ralph Holland & Co., [1912]. Size 7½ × 5, pp. 70. *Sketch-maps, Sections, and Illustrations. Price* 10*d. net. Presented by the Publishers.*

United States—Arizona. *Naturw. Wochenschrift* **11** (1912): 113–121. **Mulder.**

Die Explosion von Meteoren und der Meteorkrater von Canyon Diablo in Arizona. Von Prof. Dr. M. E. Mulder. *Illustrations.*

United States—California—Yosemite Valley. **Johnson.**

B. American G.S. **43** (1911): 826–837, 890–903.

Hanging Valleys of the Yosemite. By W. W. Johnson. *Sketch-maps, Illustration, and Section.*

United States—Communications. *B. Pan American Union* **34** (1912): 212–222. ———

Key West and Cuba. *Portrait, Sketch-map, and Illustrations.*

On the new railway from Florida to Key West as a means of communication with Cuba (see April number, p. 400).

United States—Florida—Railway. *B. American G.S.* **44** (1912): 90–93. **Harper.**

Completion of the railroad across the Florida Keys. By Roland M. Harper.

See note in vol. **39**, p. 400.

United States—Geology. *American J. Sc.* **33** (1912): 237–240. **Bowie.**

Some relations between gravity anomalies and the geologic formation in the United States. By William Bowie.

United States—Idaho—Erosion. *J. Geology* **20** (1912): 139–147. **Umpleby.**

An old erosion surface in Idaho: its age and value as a datum plane. By Joseph B. Umpleby. *Sketch-maps and Illustration.*

United States—Magnetism. **Faris.**

Department of Commerce and Labor. Coast and Geodetic Survey. Terrestrial Magnetism. Special publication, No. 9. Distribution of the magnetic declination in the United States for January 1, 1910. With isogonic chart and secular change tables. By R. L. Faris. Washington, 1911. Size 11½ × 8, pp. 14. *Map.*

United States—Migration. *B. American G.S.* **44** (1912): 97–112. **Hubbard.**

The influence of the presence, discovery and distribution of the precious metals in America on the migration of people. By George D. Hubbard.

United States—Mississippi delta. *Popular Sc. Monthly* **80** (1912): 237–245. **Hilgard.**

A new development in the Mississippi delta. By Prof. E. W. Hilgard. *Map.*

See note in the June number.

CENTRAL AND SOUTH AMERICA.

Colombia—Survey. **Nieto.**

B. Ministerio Relaciones Exteriores, Colombia **3** (1911): 645–668.

Informe del jefe de la Oficina de Longitudes. Por Julio Garzón Nieto. *Illustrations.*

Report on the progress of the survey during 1911 (cf. *Journal*, vol. **38**, p. 533).

Costa Rica—Geology. *Quart. J. Geol. S.* **68** (1912): 103–139. **Romanes.**
Geology of a part of Costa Rica. By James Romanes. *Sketch-maps, Sections, and Illustrations.*

Chile—Juan Fernandez—Geology. **Quensel.**
B. Geol. I. Univ. Upsala **11** (1912): 252–290.
Die geologie der Juan Fernandezinseln. Von P. D. Quensel. *Illustrations.*

Chile—Meteorology. **Knoche.**
Instituto Central Meteorológico y Geofisico de Chile. No. I. Observaciones en la Mina Águila, 5200 m. (Cordillera de Quimza Cruz-Bolivia.) Del 26 de Abril hasta el 12 de Septiembre de 1909. Por Walter Knoche. Santiago, 1911. Size 14½ × 10, pp. xiv. and 244. [In Spanish and German.]

Falkland Islands—Geology. *B. Geol. I. Univ. Upsala* **11** (1912): 115–229. **Halle.**
On the geological structure and history of the Falkland Islands. By Thore G. Halle. *Sketch-maps, Sections, and Illustrations.*

Panama Canal. *J. Manchester G.S.* **27** (1911): 1–15. **Leech.**
The Panama Canal. By Alderman Sir Bosdin T. Leech. *Map and Illustrations.*

Panama Canal. *R. Engineers J.* **15** (1912): 219–228. **Owen.**
Notes on the Panama Canal. By Lieut. R. A. Owen. *Sections.*

Panama Canal. *National G. Mag.* **23** (1912): 195–205. **Showalter.**
The Panama Canal. By William Joseph Showalter. *With bird's-eye view in colours.*

AUSTRALASIA AND PACIFIC ISLANDS.

Australia—Central. *J. and P.R.S. New South Wales* **45** (1912): 187–203. **Cleland.**
On the occurrence of explosive or booming noises (Barisàl Guns) in Central Australia. By J. Burton Cleland.
See note in the June number.

New Guinea—Dutch. *Ts. K. Nederlandsch Aardr. Genoots.* **29** (1912): 210–220. **Staal.**
De exploratie van Nieuw-Guinea. Door J. J. S[taal].

New Guinea—Dutch. *Ts. K. Nederlandsch Aardr. Genoots.* **29** (1912): 137–153. **Viegen.**
Oorsprongs-en afstammingslegenden van den Marindinees (Zuid Nieuw Guinea). Door Jos. Viegen.

New Guinea—Dutch—Dwarfs. **Kock.**
Ts. K. Nederlandsch Aardr. Genoots. **29** (1912): 154–170.
Eenige ethnologische en anthropologische gegevens omtrent een dwergstam in het bergland van Zuid Nieuw-Guinea. Door M. A. Kock. *Illustrations.*

New Guinea—Papua. *Victoria G.J.* **28** (1910–11): 31–63. **Bell.**
Exploring in Papua. By Leslie Livingstone Bell.
Account of the expedition under Mr. Staniforth Smith (*Journal*, April, 1912).

New South Wales—Fisheries. **Stead.**
New South Wales. The future of Commercial Marine Fishing in New South Wales. By David G. Stead. Fisheries Branch, Chief Secretary's Department, N.S.W. Sydney, 1911. Size 8½ × 5½, pp. 18. *Illustrations.*

Torres Straits—Anthropology. ——
Reports of the Cambridge Anthropological Expedition to Torres Straits. Volume IV., Arts and Crafts. Cambridge: University Press, 1912. Size 11½ × 8½, pp. xxiv. and 394. *Illustrations. Presented by the Publishers.*

POLAR REGIONS.

Antarctic—British Expedition. *La G., B.S.G. Paris* **25** (1912): 261–268. **Rabot.**
L'expedition Scott vers le Pôle sud. Par Charles Rabot.

Antarctic—Fauna. **Théel.**
K. Svenska Vetenskaps-A. Handlingar **47** (1911): No. 1, pp. 36.
Priapulids and Sipunculids dredged by the Swedish Antarctic Expedition, 1901–1903, and the phenomenon of Bipolarity. By Hjalmar Théel. *Illustrations.*

Antarctic—German Expedition. *Z. Ges. E. Berlin* (1912): 81–83. ——
Deutsche Antarktische Expedition. *Illustration.*

Arctic—Jan Mayen—Stackhouse Expedition. **Russell.**
B. American G.S. **43** (1911): 881–890.

Jan Mayen expedition of 1911. By W. S. C. Russell. *Sketch-map and Illustrations.*

Mr. J. F. Stackhouse's expedition (*Journal*, January, 1912, p. 79).

Greenland—Danish Expedition. *G. Ts.* **21** (1912): 167–177. **Koch.**

Danmark-Ekspeditionens Kort. Af Kaptajn J. P. Koch. *Maps and Illustrations.*

The cartographical results of the expedition in the *Danmark*. The maps (general and special) have also appeared in the *Meddelelser om Grønland*.

Greenland—Ethnology. *G. Ts.* **21** (1912): 177–191. **Thostrup.**

Den fortidige Bebyggelse of Grønlands Nordøstkyst. Danmark-Ekspeditionens etnografiske Arbejder. Af Chr. Bendix Thostrup. *Illustrations.*

MATHEMATICAL GEOGRAPHY.

Cartography. **Dickson.**

Maps: How they are made; how to read them. By Dr. H. N. Dickson. London: G. W. Bacon & Co., 1912. Size 7½ × 5, pp. 66. *Sketch-maps, Diagrams, and Illustrations. Price* 6*d. Presented by the Publishers.*

Cartography. **Service Géographique (France).**

Service Géographique de l'Armée. Rapport sur les travaux exécutés en 1910. Paris, 1911. Size 10 × 6½, pp. 62. *Maps and Diagrams.*

Compass. **Schück.**

Alte Schiffskompasse und Kompassteile im Besitz Hamburger Staatsanstalten. Von A. Schück. Hamburg, 1910. Size 9½ × 6, pp. 48. *Illustrations. Presented.*

Compass. **Schück.**

Der Kompass. I. 46 Tafeln und Verzeichniss derselben. Von A. Schück. Hamburg: Emil Korff, 1911. Size 14 × 11½, pp. 18. *Illustrations. Presented.*

Geodesy. *Abh. k.k. G. Ges. Wien* **9** (1911): No. 2, pp. 40. **Böhm.**

Ueber Berechnungsformeln des Erdsphäroides und die Besselschen Konstanten. Von Dr. August Böhm Edler von Böhmersheim.

Surveying. *Min. and P.I. Civil Engineers* **187** (1912): 241–250. **Dempster.**

Notes on a system of surveying with a Tacheometer. By Herbert George Dempster. *Illustrations.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climatology. **Hildebrandsson.**
K. Svenska Vetenskaps-A. Handlingar **45** (1910): No. 11, pp. 22.

Quelques recherches sur les centres d'action de l'atmosphère. Par H. Hildebrand Hildebrandsson. IV. Sur la compensation entre les types des saisons simultanés en différentes régions de la terre. *Diagrams.*

Coast erosion. *C.R.A. Sc. Paris* **154** (1912): 401–403. **Parvu.**

La défense naturelle des rochers contre l'action destructive de la mer. Par M. Parvu.

On the protective action of the hard shells of cirrhipods.

Denudation. *G.Z.* **18** (1912): 79–98. **Passarge.**

Ueber die Abtragung durch Wasser, Temperaturgegensätze und Wind, ihren Verlauf und ihre Endformen. Von S. Passarge. *Diagram.*

Erosion. *J. and P.R.S. New South Wales* **45** (1912): 116–136. **Andrews.**

Erosion and its significance. By E. C. Andrews.

Erosion. *Petermanns M.* **58** (1912): I. 145–147. **Rekstad.**

Ueber die Erosion der Meeresbrandung und die des strömenden schuttbeladenen Wassers. Von J. Rekstad. *Illustrations.*

Geomorphology—Fiords. *Nature* **89** (1912): 179–183. **Gregory.**

Fiords in relation to Earth-movements. Abridged from a lecture delivered by Prof. J. W. Gregory.

Geomorphology—Oceanic relief. **Hull.**

Monograph on the sub-oceanic physiography of the North Atlantic Ocean. By Edward Hull. London: E. Stanford, 1912. Size 18 × 12½, pp. viii. and 42. *Maps. Price* 21*s. net.*

Geomorphology—Rivers. *B.S.G. Italiana*, V., 1 (1912): 465–478. **Azzi.**

La direzione dei corsi d'acqua e lo sviluppo della superficie topografica. Del dott. Girolamo Azzi. *Sketch-map and Diagrams.*

Geomorphology—River-terraces. **Dietrich.**

Entstehung und Umbildung von Flussterrassen. Von Dr. Bruno Dietrich. (Sonderabdruck aus *Geologische Rundschau*, Band 11, Heft. 8.) Leipzig, 1911. Size 9 × 6, pp. 445-454. *Sections.*

Oceanic life. **Joubin.**

La vie dans les océans. Par Dr. L. Joubin. Paris: E. Flammarion, 1912. Size 7½ × 5, pp. 334. *Illustrations. Price* 3.50 *fr.*

Oceanography—Indian Ocean. **Gardiner.**

The Percy Sladen Trust Expedition to the Indian Ocean in 1908, under the leadership of J. Stanley Gardiner. Vols. 2 and 3. (*Transactions* of the Linnean Society of London; Second Series, Vols. 13 and 14: Zoology.) London, 1909–10, 1910–12. Size 12 × 9½, pp. (vol. 2) 474, (vol. 3) 486. *Maps and Illustrations. Presented by Prof. J. Stanley Gardiner.*

Phytogeography. **Rikli.**

Lebensbedingungen und Vegetationsverhältnisse der Mittelmeerländer und der atlantischen Inseln. Von Prof. Dr. M. Rikli. Jena: Gustav Fischer, 1912. Size 9 × 6½, pp. xii. and 172. *Sketch-maps and Illustrations.*

Phytogeography—Fungi. **Lister.**

A monograph of the Mycetozoa: a descriptive catalogue of the species in the Herbarium of the British Museum. By Arthur Lister. Second edition, revised by Gulielma Lister. London: British Museum, 1911. Size 9 × 5½, pp. xi. and 320. *Illustrations. Presented by the British Museum (Natural History).*

Volcanoes. **Komorowicz.**

Vulkanologische Studien auf einigen Inseln des Atlantischen Oceans. Von Maurice v. Komorowicz. Stuttgart: E. Schweizerbart, 1912. Size 11½ × 9, pp. xvi. and 190. *Maps, Sections, and Illustrations. Presented by the Author.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography—Cities. *Deuts. Rundschau G.* **33** (1910–11): 385–390. **Hassinger.**

Die geographische Verbreitung der Grossstädte auf der Erde. Von Dr. H. Hassinger. *Map.*

Anthropogeography—Head-hunting. **Funke.**

Deuts. Rundschau G. **32** (1909–10): 75–79, 109–115.

Die geographische Verbreitung der Kopfjagd. Von Max Funke.

Anthropology. **Lull.**

Glacial man. By Richard Swann Lull. (From the *Yale Review* for April, 1912.) [Yale, 1912.] Size 10 × 6½, pp. 376–389.

Historical—Capella. *Riv. G. Italiana* **18** (1911): 177–191, 382-391, 584–603. **Mori.**

La misurazione eratostenica del grado ed altre notizie geografiche della "Geometria" di Marciano Capella. Ricerche di Assunto Mori.

Historical—Ibn Batuta. **Mžik.**

Die Reise des Arabers Ibn Batuta durch Indien und China (14. Jahrhundert). Bearbeitet von Dr. Hans von Mžik. Hamburg: Gutenberg, 1911. Size 9 × 6, pp. 490. *Maps. Price* 6*s.*

Political Geography. **Fox.**

Problems of the Pacific. By Frank Fox. London: Williams & Norgate, 1912. Size 9 × 5½, pp. iv. and 294. *Price* 7*s.* 6*d. net. Presented by the Publishers.*

BIOGRAPHY.

Banks. **Smith.**

The life of Sir Joseph Banks, President of the Royal Society: with some notices of his friends and contemporaries. By Edward Smith. London: John Lane, 1911.

Size 9 × 5½, pp. xvi. and 348. *Illustrations. Price* 12*s.* 6*d. net. Presented by the Publisher.*

Dutton. *B. Seismological S. America* 1 (1911): 137–142. **Diller.**
Major Charles Edward Dutton. By J. S. Diller. *Portrait.*

GENERAL.

British Empire. **Chute.**
Geography notes. British Empire. By J. C. Chute. London: J. M. Dent & Sons, 1912. Size 8½ × 5½, pp. vi. and 92. *Sketch-map and Sections. Price* 2*s. net. Presented by the Publishers.*

Education—Text-book. **Dryer.**
High School Geography: physical, economic, and regional. By Charles Redway Dryer. New York, &c.: American Book Co., [1912]. Size 8 × 5½, pp. 536. *Sketch-map and Illustrations. Presented by the Author.*

Education—Text-book. **Reynolds.**
Regional Geography: the World. By J. B. Reynolds. London: A. & C. Black, 1912. Size 8½ × 5½, pp. viii. and 360. *Sketch-maps. Price* 3*s.* 6*d. Presented by the Publishers.*

Explorers. *Scottish G. Mag.* 28 (1912): 134–146. **Darwin.**
On the personal characteristics of great explorers. By Major Leonard Darwin.

Geographical progress. *B.S.R. Belge G.* (1911): 349–391. **Kraentzel.**
La Géographie en Allemagne et en Autriche. Par F. Kraentzel. *Diagrams.*

Geography. *Ann. G.* 21 (1912): 1–19. **Davis.**
L'esprit explicatif dans la géographie moderne. Par Prof. W. M. Davis.

Geography. *B. American G.S.* 44 (1912): 27–39. **Genthe.**
Comment on Colonel Close's address on the purpose and position of geography. By Dr. Martha Krug Genthe.

German Colonies—Cartography. **Eckert**
Deutsche Kolonialzeitung 27 (1910): 173–174, 191–192, 205–206, 224–226.
Entwicklung und gegenwärtiger Stand unserer Kolonialkartographie. Von Prof. Dr. Max Eckert.

History of Cartography. **Stevenson.**
Genoese world map, 1457. Facsimile and critical text incorporating in free translation the studies of Prof. Theobald Fischer, revised, with the addition of copious notes, by Dr. Edward Luther Stevenson. New York, 1912. Size 9½ × 6½, pp. 66. *Large facsimile, separate; smaller accompanying text.*

Photography. *Alpine J.* 26 (1912): 1–4. **Clark.**
Colour Photography for Mountaineers. By Dr. Inglis Clark. *Illustrations.*

Statistics. **Hübner and Juraschek.**
Otto Hübners Geographisch-statistische Tabellen aller Länder der Erde. Von Dr. Franz von Juraschek. 59. Ausgabe für das Jahr 1910. Frankfurt-am-Main, Henrich Keller, [1912]. Size 5½ × 8, pp. x. and 104.

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

Belgium. **De Boeck.**
Plan de la Ville d'Anvers. Scale 1 : 1,500 or 5·5 inches to 1 stat. mile. Brussels: A. De Boeck, [1912].

Belgium. **Hoste.**
Plan instantané de la Ville de Gand. 9e édition. Scale 1 : 7000 or 9 inches to 1 stat. mile. Ghent: Ad. Hoste, [1912].

France. **Ministre de l'Intérieur, Paris.**

Carte de la France dressée par ordre du Ministre de l'Intérieur. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. Sheets : V.–17, Quimperlé ; IX.–13, Granville ; X.–19, Chalonnes ; XI.–14, Domfront ; XII.–27, Barbezieux ; XIII.–19, Tours ; XVIII.–6, Lille ; XXIII.–22, Lons-le-Saunier ; XXV.–19, Baume-les-Dames ; XXV.–25, Sallanches ; XXV.–26, Albertville ; XXV.–28, Modane ; XXV.–34, Draguignan. New editions. Paris : Hachette et Cie, 1911–12. *Price* 0.80 *fr. each sheet.*

Germany. **Sympher.**

Karte der Deutschen Wasserstrassen unter besonderer Berücksichtigung der Tiefen- und Schleusen-Verhaltnisse von Sympher und Maschke. 4. wesentlich veränderte Auflage. Im Auftrage des Herrn Ministers der öffentlichen Arbeiten nach amtlichen Unterlagen bearbeitet von Dr. Ing. Sympher, Geheimer Ober-Baurat. Scale 1 : 800,000 or 1 inch to 12·6 stat. miles. 4 sheets. Berlin : Gea Verlag G.-m. B., 1912.

An outline map of the German Empire, giving by means of various colours, symbols and figures, a considerable amount of information concerning the waterways. Although stated to be a new edition, the map has been entirely redrawn.

Hungary. **Hoffmann.**

Carte Routière de la Hongrie. Scale 1 : 1,300,000 or 1 inch to 20·5 stat. miles. Budapest : Alfred Hoffmann, [1912].

Russia. **Topographical Dept., General Staff, St. Petersburg.**

Map of European Russia. [In Russian.] Scale 1 : 420,000 or 1 inch to 6·6 stat. miles. Sheets 1, 5, 6, 14, 15, 29, 43, 44, 57, 58. St. Petersburg : Topographical Department, General Staff, 1910–1911.

Scandinavia. **Törnebohm.**

Geologisk Oversiktskarta över Skandinavien, för Skolornas behov sammanställd av A. E. Törnebohm. Scale 1 : 1,000,000 or 1 inch to 15·8 stat. miles. 8 sheets. Stockholm : P. A. Norstedt & Söners, 1908.

A useful general geological map, giving the whole of Sweden, Norway and Denmark, for which reason it is of special interest and educational value.

ASIA.

Turkey. **Huber.**

Empire Ottoman. Carte Statistique des Cultes Chrétiens dressée par Major R. Huber. Scale 1 : 1,250,000 or 1 inch to 19·7 stat. miles. 4 sheets. Cairo : Baader & Gross, [1912].

This map shows by various symbols and colours the distribution of the Christian cults and sects in Asiatic Turkey. The corresponding map of European Turkey was published two years ago, and a notice of it appeared in the *Geographical Journal* for December, 1910. The present map is similar in general design and arrangement to that previously published, and contains a large amount of statistical information that cannot fail to be of interest to all concerned with the condition of Christianity in the East.

AFRICA.

Africa. **Geographical Section, General Staff.**

Africa. Scale 1 : 125,000 or 1 inch to 1·9 stat. miles. Sheet : South A 37–A 1, Nakuru, East Africa Protectorate. Published by the Geographical Section, General Staff, 1912. London Agents : E. Stanford, Ltd., Sifton Praed, T. Fisher Unwin. *Price* 2*s. net each sheet. Presented by the Director of Military Operations.*

French Equatorial Africa. **Delingette.**

Carte Générale de l'Afrique Équatoriale Française publiée par ordre de M. le Gouverneur Général M. Merlin, dressée et dessinée par G. Delingette sous la direction de M. l'Administrateur Bruel, Chef du Service Géographique. Scale 1 : 1,000,000 or 1 inch to 15·8 stat. miles. Sheets 1, 2, 3, and 4. Paris : A. Challamel, [1912].

These are four sheets of the map of French Equatorial Africa referred to in the *Geographical Journal* of May, 1910, with the territory ceded last year by France to Germany, and that ceded by Germany to France indicated by colours, and the boundaries carefully marked.

Tunis. **Service Géographique de l'Armie, Paris.**

Carte de la Tunisie. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. Sheets : LXXXV., Sidi Chemmakh ; LXXXVI., Rass el Kelb ; XCIII., Zarzis. Paris : Service Géographique de l'Armée, 1912.

AMERICA AND WEST INDIES.

Canada. **Rand, McNally & Co.**

The Rand-McNally Indexed County and Township Pocket Map of Manitoba. Scale 1:1,013,760 or 1 inch to 16 stat. miles. Chicago and New York: Rand, McNally & Co., 1912. *Price* $0.25.

Cuba. **War Department, Washington.**

Map of Cuba. Prepared in the War College Division, General Staff, War Department, Washington. Scale 1:600,000 or 1 inch to 9·5 stat. miles. 2 sheets. Washington, 1912.

This map is based on military reconnaissances by the United States army during the first and second occupation of Cuba, 1898–1902 and 1906–1909. Hills are shown by brown horizontal form lines, and altogether it is a clear and useful general map.

United States. **Rand, McNally & Co.**

The Rand-McNally Indexed County and Township Pocket Maps: Florida, scale 1:1,203,840 or 1 inch to 19 stat. miles; Kansas, scale 1:1,013,760 or 1 inch to 16 stat. miles; Massachusetts, scale 1:443,520 or 1 inch to 7 stat. miles. Chicago and New York: Rand, McNally & Co., 1912. *Price* $0.25 *each.*

United States. **U.S. Geological Survey.**

Geologic Atlas of the United States. Folios: 174, Johnstown, Pennsylvania; 175, Birmingham, Alabama; 176, Sewickley, Pennsylvania; 177, Burgettstown-Carnegie, Pennsylvania; 178, Foxburg-Clarion, Pennsylvania; 179, Pawpaw-Hancock, Maryland-W. Virginia-Pennsylvania; 180, Claysville, Pennsylvania; 181, Bismarck, N. Dakota; 182, Choptank, Maryland. Washington: Department of the Interior, U.S. Geological Survey, 1910–11. *Presented by the Director, U.S. Geological Survey.*

GENERAL.

World. **Debes.**

E. Debes' Neuer Handatlas über alle Teile der Erde in 65 Haupt und über 130 Nebenkarten mit alphabetischem Namenverzeichnis. 4. Stark vermehrte und verbesserte Auflage. Lieferungen 17 u. 18. Leipzig: H. Wagner & E. Debes, 1912. *Price* 80 *Pf. each part.*

These parts contain the following maps:—Lieferung, 17: No. 1*a* Südpolar-Karte; 37, Griechenland. Lieferung 18: 22*a* Deutschlands wichtigste Kohlen- und Industriegebiete; 55, Vereinigte Staaten.

World. **Eckert.**

Wirtschafts-Atlas der Deutschen Kolonien auf Veranlassung der Deutschen Kolonialgesellschaft entworfen und bearbeitet von Prof. Dr. M. Eckert. Topographische Grundlage von P. Sprigade und M. Moisel. Berlin; Dietrich Reimer (Ernst Vohsen), [1912].

An atlas containing fifty-two sheets of maps, plans and diagrams, illustrative of the economic products, imports and exports, meteorology, density of population, etc., of the German colonies. The data have been taken from the latest official sources, and for its size, 12½ inches by 6¼ inches, the atlas contains a large amount of statistical and other information, the diagrams being specially graphic and instructive.

World. **Johnston.**

A School Atlas of Ancient History. Thirty-three maps and plans printed in colours, with plans of cities in black and white, and notes on historical geography and index to place-names. Edinburgh and London: W. & A. K. Johnston, Ltd., 1912. *Price* 2*s. net. Presented by the Publishers.*

A small cheap atlas consisting of twenty-seven maps. The first group illustrates the climate, structure, and vegetation of the countries of the Mediterranean region in which ancient civilization arose and developed. The second group deals with the eastern empires which preceded the rise of Greece. The third is devoted to the history of Greece, and the last to the expansion of the Roman Empire. There are black and white plans of Jerusalem, Athens and Rome at the end of the text, and index to place-names.

World. **Marconi's Wireless Telegraph Co.**

Wireless Map of the World. Equatorial scale 1:40,500,000 or 1 inch to 639·2 stat. miles. Published by Marconi's Wireless Telegraph Company, Ltd. London, 1912. *Price* 3*s.*

An outline map on Marconi's projection, showing wireless stations opened and

proposed at the present date. By different symbols in black are distinguished stations open to ship and shore communication, high power stations open to ship and shore communication, high power restricted public service, private stations, high power private stations, the Imperial scheme, and the American Trans-Ocean scheme. Insets on larger scales are given of parts where there are too many wireless stations to be properly shown on the general map.

CHARTS.

Admiraly Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, from June 30 to July 13, 1912. *Presented by the Hydrographer, Admiralty.*

New Editions—No. 2, The British islands, 3*s*. 2631, England, south coast: Portsmouth harbour, 5*s*. 1170*a*, England, west coast: Holyhead to Great Ormes head (Plan: Bull bay and Amlwch harbour), 3*s*. 3110, Scotland, east coast: Cromarty Firth anchorage, 3*s*. 1825*a*, The Irish channel, sheet I. (Plans: Belfast lough. Strangford narrows, Lough Larne entrance, Campbelton loch), 3*s*. 2116, Baltic entrance: Little Belt (Plans: Aarhus harbour, Juelsminde harbour, Svendborg sound, Svendborg harbour), 4*s*. 1334, West Indies: Old Providence island and coral bank (Plan: Catalina harbour), 2*s*. 1301, Plans on the coast of Chile: Carrizal Bajo bay, Constitucion harbour, Mejillones del Sur bay, Cobija bay and Gatico cove, Tocopilla road, Blanco Encalada road, 3*s*. 1277, South America, Chile: Point Grande to Point San Francisco (Plans: Chimba cove, El Cobre cove, Guanillos cove, Abtao cove), 2*s*. 27, Persian gulf: Abú Shahr (Bushire), 3*s*. 1199, China, east coast: Kuo shan islands to the Yang tse kiang, including the Chusan archipelago, 4*s*. 781, Pacific ocean, north-west sheet, 3*s*. 980, Pacific ocean: Caroline islands, 3*s*.

(*J. D. Potter, Agent.*)

America, North. **U.S. Weather Bureau.**

Meteorological chart of the Great Lakes, August, 1912. Washington: Department of Agriculture, U.S. Weather Bureau, 1912. *Presented by the U.S. Weather Bureau.*

Atlantic, North. **U.S. Weather Bureau.**

Meteorological chart of the North Atlantic Ocean, August, 1912. Washington: Department of Agriculture, U.S. Weather Bureau, 1912. *Presented by the U.S. Weather Bureau.*

Indian Ocean. **U.S. Weather Bureau.**

Meteorological chart of the Indian Ocean, August, 1912. Washington: Department of Agriculture, U.S. Weather Bureau, 1912. *Presented by the U.S. Weather Bureau.*

Pacific, North. **U.S. Weather Bureau.**

Meteorological chart of the North Pacific Ocean, August, 1912. Washington: Department of Agriculture, U.S. Weather Bureau, 1912. *Presented by the U.S. Weather Bureau.*

PHOTOGRAPHS.

Arabia. **Poynter.**

Ten photographs of Salif, Yemen, taken by Hugh E. Poynter, Esq. *Presented by Hugh E. Poynter, Esq.*

(1–3) Salif; (4) Telegraph office; (5) Houses of the staff; (6) Ottoman Public Debt Administrative Office; (7 and 8) Rock salt quarry; (9) Salt pans; (10) Loading a caravan.

N.B. It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

NOTE.

This map has been constructed from the "Sketch Map of the Glaciers of Kangchenjunga," by Prof. J. Garwood; scale 1:125,000; published in the "Geographical Journal," July, 1902. Map of Sikkim, prepared for the Bengal Government, from an original based on Sheet No. 7 N.W., N.E. Trans-Frontier, 3rd edition; scale 1:253,444; published under the direction of the Surveyor-General of India, May, 1906; and from a MS. drawing, giving corrections to Prof. Garwood's map, prepared chiefly from photographs taken by Dr. A. M. Kellas. The heights are from the Survey of India map of Sikkim.

NORTHERN SIKKIM
To illustrate the paper by
Dr A.M. KELLAS
Scale 1: 300,000 or 1 inch - 4·7 Stat. Miles.
0
5
10 Stat. Mls.
Route of Dr Kellas 1911.
88° 15'
28°
27° 45'
Chorten Nima La
The Sentinel
21,100
Chabuk La
The Outlier
Jonsong Pk
Jonsong La
Langpo Pk
22,600
Longridge Mt.
Longridge Pass
Jonsong Glacier
Lhonak La
Pangpemas
Kangchenjunga
Wedge Pk
Green Lake
Kangchenjunga Glacier
Kangchenjunga
KANGCHENJUNGA
Jannu
Zemu Gap
Simvu
Talung Glacier
Kabru
24,020
Guichia La
Pandim
88° 15'

Published by the Royal Geographical Society.

NORTHERN SIKKIM
KELLAS